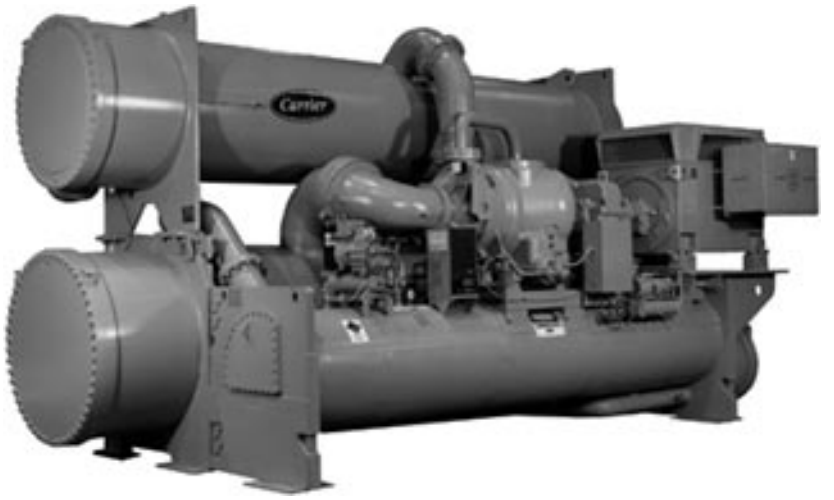
Product Data

17EX
Externally Geared Centrifugal Liquid Chiller
50/60 Hz

1500 to 2250 Nominal Tons (5280 to 7910 kW)



Carrier's Externally Geared 17EX Open Drive Centrifugal Liquid Chillers operate with environmentally safe HFC-134a. These chillers combine industrial quality with superior efficiency in a packaged design to minimize system costs. The Carrier 17EX chiller features:

- Single-Piece Shipment and Modular Construction
- Externally Geared Open Drive Motor, 2-Stage Compressor Design with Interstage Economizer
- Positive Pressure Design Using Environmentally Safe HFC-134a Refrigerant

Features/Benefits

The externally geared 17EX open drive centrifugal liquid chiller features:

Single-piece factory package — The 17EX chiller is completely assembled in the factory and shipped in one piece to the jobsite. This allows each unit to be tested before delivery to the customer. It also ensures that every aspect of the unit meets stringent quality standards specified by Carrier. One piece shipment eliminates costly and time consuming field assembly.

Modular construction — The cooler, compressor, condenser, and economizer/storage vessel assemblies are completely bolted together, making the 17EX chiller ideally suited for replacement projects where ease of disassembly and re-assembly at the jobsite are essential.

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Application flexibility/two-stage compressor — By providing a wide assortment of compressor and gear arrangements as well as 2 stages of compression, the 17EX chiller is an efficient, quality package ideally suited for domestic chilled water, export chilled water, brine chilling, and ice making applications.

The 17EX unit can be used to chill either water or brine. The data in this book applies to either application. Applications using corrosive brines may require using special tube, tubesheet, and waterbox materials which are special order items.

Lubrication system — This forced lubrication system consists of an electrically-driven oil pump, filter, heater, and water-cooled oil cooler. It provides an adequate supply of oil to the transmission gears and all bearing surfaces during start-up, operation, and coastdown. The electrically driven oil pump is supplied by a separate power line ensuring an adequate oil supply in the event of compressor power interruptions. A microprocessor-controlled oil heater prevents excessive absorption of refrigerant into the oil during compressor shutdown.

Variable inlet guide vanes — These vanes are connected with aircraft-quality cable and controlled by a precise electronic actuator. Chilled water temperature is maintained within ± .5 F (.3 C) of desired set point without surge, cavitation, or undue vibration. The vanes regulate inlet flow to provide high efficiency through a wide, stable operating range without hot gas bypass.

Double helical industrial gears — Unlike single helical gears, double helical gears have a greater tooth-contact area which can transmit higher horsepower loads more smoothly. In addition, to ensure a long, dependable life for all components in the system, this design eliminates axial thrust loads generated in the transmission of power.

Split-sleeve, steel back, babbitt-lined journal bearing — The 17EX chiller uses 2 steel back, babbitt-lined bearings on both sides of the thrust bearing to form a ''fully supported'' internal shaft. The steel backing provides structural strength for the bearing, while the babbitt material provides a superior bearing surface. The split-sleeve design facilitates bearing inspection without shaft removal. This makes for a very solid rotating assembly which reduces heat, wear, vibration, and the possibility of shaft failure.

Tilting pad, self-equalizing, babbitt-lined, Kingsbury-type thrust bearing — The Kingsbury-type thrust bearing employs an expanded equalized surface that faces a rotating disc on the shaft. This surface is comprised of multiple pads made from babbitt material. Each pad is supported by plates that allow the pads to self-align and that permit field adjustments. During operation, the pads take on a wedge shape. This formation ensures that the load-carrying surfaces of the bearing are separated by a relatively thick film of lubricant, preventing metal-to-metal contact. In case of reverse shaft rotation, the pads on the thrust bearing can realign and form a wedge-shape in the opposite direction, consequently reducing wear and increasing bearing life.

Large inspection opening — Each compressor is equipped with an access cover to facilitate bearing and gear inspection without compressor disassembly. This makes the 17EX chiller ideal for yearly inspections and preventive maintenance programs.

Run-tested compressor — Every compressor assembly is run-tested in accordance with stringent Carrier engineering requirements. These tests, performed before final chiller assembly, ensure proper and reliable operation.

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Model number nomenclature

17EX 47 47 583 J FH 66 1 –

Model Description
17EX — Open Drive Centrifugal Liquid Chiller

Cooler Size*
45-48

Condenser Size
45-47
55-57

Compressor Size
531 through 599

Gear Code

G (60 Hz)	P (50 Hz)
J (60 Hz)	S (50 Hz)
L (50 and 60 Hz)	
N (50 and 60 Hz)	

Special Order Code
– — Standard
S — Special Order

Waterbox Code
1 — Marine Waterbox Cooler/ Marine Waterbox Condenser
2 — Marine Waterbox Cooler/ NIH Waterbox Condenser
3 — NIH Waterbox Cooler/ Marine Waterbox Condenser
4 — NIH Waterbox Cooler/ NIH Waterbox Condenser

Motor Voltage

64 — 2400-3-60	53 — 3000-3-50
65 — 3300-3-60	54 — 3300-3-50
66 — 4160-3-60	55 — 6300-3-50
67 — 6900-3-60	

Motor Size

FA	FE	HA	HF	JA	JF
FB	FG	HB	HG	JB	JG
FC	FH	HC	HH	JC	JH
FD	FJ	HD	HJ	JD	JJ
	FK		HK		JK

NIH — Nozzle-In-Head

*Any available cooler size can be combined with any available condenser size.

NOTE: For details on motor size designations, see below.

F A

Open Drive Motor Type
F — ODP (Open Drip Proof)
H — WPII (Weather Protected, Type II)
J — TEWAC (Totally Enclosed Water-to-Air Cooled)

Motor Horsepower (kW)

	hp	(kW)	S.F. (Service Factor)
A	1250	(932)	1.15
B	1500	(1119)	1.15
C	1750	(1305)	1.15
D	2000	(1492)	1.15
F	1250	(932)	1.05
G	1500	(1119)	1.05
H	1600	(1194)	1.05
J	1750	(1305)	1.05
K	2000	(1492)	1.05

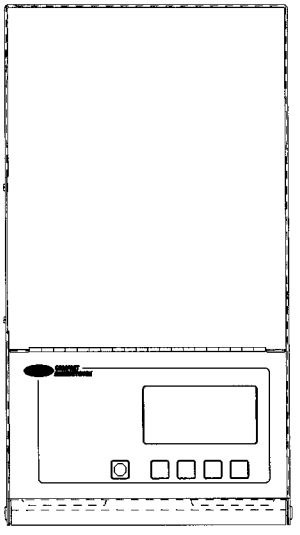
ASME 'U' STAMP

ARI (Air Conditioning and Refrigeration Institute) PERFORMANCE CERTIFIED (60 Hz Only)

Features/Benefits (cont)

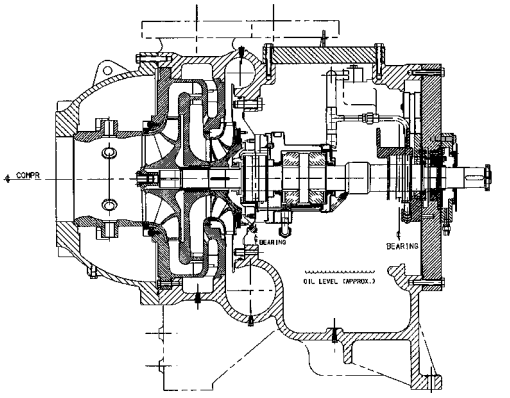
HEAT EXCHANGERS

- ASME stamp on both refrigerant and water-sides of heat exchangers for increased reliability
- Optional marine waterboxes eliminate disassembly of field piping, saving on service time during tube cleaning
- High-performance internally and externally enhanced tubes provide excellent heat transfer efficiencies
- Closely spaced intermediate support sheets prevent tube sagging and/or vibration
- Double-grooved tube sheets, with tubing rolled and expanded at both end sheets, provide leak-tight integrity
- Condenser impingement baffle eliminates tube vibration and increases heat exchanger efficiency
- Condenser thermal economizer increases refrigerant cycle efficiency



MICROPROCESSOR CONTROL SYSTEM

- Easy to read 16-line by 40-character LCD display
- ''All in one glance'' access to key chiller operating data simplifies chiller-user interface
- Monitors over 100 functions and conditions for complete system control
- Displays over 125 operating and diagnostic conditions for the most detailed information available
- Carrier Comfort Network (CCN) compatibility provides a system solution to controls applications

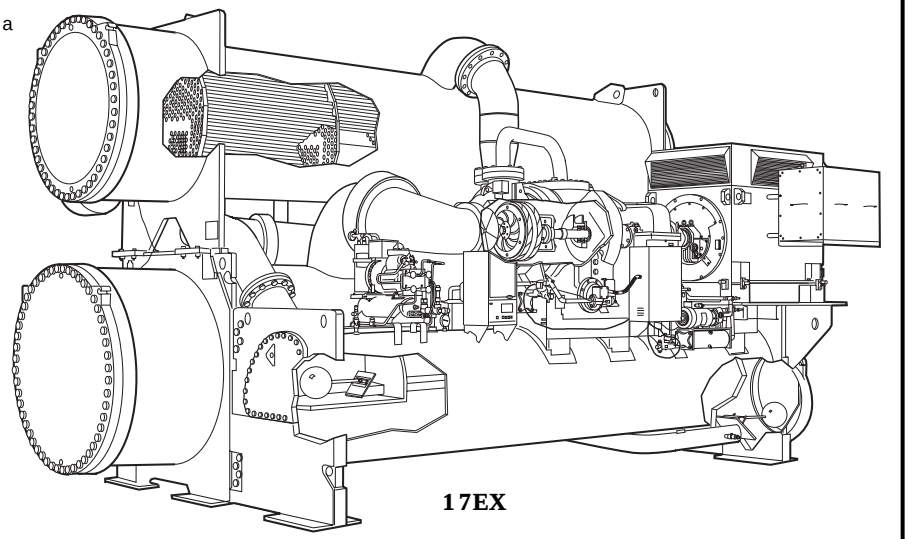


2-STAGE COMPRESSOR

- Hermetically-sealed lubrication package provides adequate oil supply at start-up, operation, and coastdown
- Variable inlet guide vane capacity control provides stable operation without hot gas bypass
- Double helical gears transmit higher shaft load and eliminate gear thrust load
- Split sleeve, steel back, babbitt-lined journal bearings facilitate bearing inspection without shaft removal
- Tilting pad, self-equalizing, babbitted Kingsbury-type thrust bearing absorbs axial thrust, increasing compressor life
- Large inspection opening facilitates bearing and gear inspection without compressor disassembly
- Refrigerant or water-cooled oil cooler
- Compressor is run-tested, ensuring proper and reliable operation
- Coastdown oil reservoir ensures proper lubrication during power outage shutdowns

EXTERNALLY GEARED 17EX OPEN DRIVE CENTRIFUGAL LIQUID CHILLER

- Single-piece modular construction makes the 17EX ideally suited for new construction or replacement projects
- Externally geared, open-drive, 2-stage compressor design with interstage economizer increases refrigeration effect and cycle efficiency
- Positive pressure design uses environmentally-safe HFC-134a refrigerant



17EX

FLASH ECONOMIZER/STORAGE VESSEL AND PUMPOUT UNIT

- Increases refrigeration effect and cycle efficiency
- Reliable float valves provide precise refrigerant flow control at any load condition
- Bolt-on covers allow for easy inspection
- Eliminates remote storage system
- Meets EPA (Environmental Protection Agency) standards
- Prevents refrigerant leakage
- Allows evacuation without operating main compressor
- Saves on service time

SINGLE-PIECE MODULAR CONSTRUCTION

- Single-piece factory package eliminates field assembly on new construction projects, reducing installation expense
- Modular construction allows for field disassembly and re-assembly on replacement projects, also reducing installation expense

The heat exchangers feature:

Pressure-tested vessels — Each heat exchanger (water-side) is hydrostatically tested at 150% of design pressure. The entire chiller assembly is pneumatically burst-tested at 125% of design pressure and then subjected to a standing vacuum test. This increases unit reliability and ensures safe chiller operation.

ASME certified construction — ASME ''U'' stamp and nameplate on both the refrigerant and water-sides of the chiller for safety, reliability, and long life.

Marine waterboxes — The marine waterboxes, optional on both cooler and condenser, facilitate tube cleaning and eliminate the need to disassemble piping.

High-performance tubing — Heat exchanger tubes can be internally and externally enhanced for high efficiency. A wide range of alternate tube types and materials is available.

Double-grooved tube sheet holes — Tubing is rolled and expanded into double grooved tube sheets to eliminate the possibility of leaks between the water and refrigerant system.

Closely-spaced intermediate support sheets — Tubes in the cooler and condenser are supported by closely-spaced intermediate support sheets that prevent tubes from sagging and vibrating.

Tube expansion at intermediate support sheets — Because of the volatile environment in the cooler heat exchanger, tubes are expanded into each intermediate support sheet, preventing unwanted tube movement and vibration.

Condenser impingement baffle — This feature prevents direct impingement of high velocity compressor discharge gas onto the condenser tubes. The baffle eliminates the related vibration and wear of the tubes and distributes the refrigerant flow evenly over the length of the vessel for improved efficiency.

Flash subcooler — The flash subcooler, located in the bottom of the condenser, brings warm condensed refrigerant into contact with the inlet (coldest) water tubes. This subcools the liquid to a temperature less than its condensing temperature. Therefore, the overall refrigeration cycle efficiency is increased, resulting in lower power consumption.

The flash economizer/storage vessel features:

Integrated economizer/storage vessel with pumpout unit — This system is self-contained, easy to operate, and more cost effective than remote storage options. As a self-contained unit, the 17EX chiller can be applied to applications that incorporate more than one type of refrigerant without the cost penalty of requiring additional remote storage systems. Additionally, the optional pumpout compressor meets the EPA's (Environmental Protection Agency) vacuum level requirements that mandate minimizing refrigerant emissions during service.

Interstage flash economizer — The liquid refrigerant leaving the condenser passes through 2 pressure reducing devices in the economizer/storage vessel before reaching the cooler. After going through the first device, some of the liquid flashes because of the sudden drop in pressure. It is drawn off to the inlet of the compressor second stage, reducing the first stage weight flow and horsepower. As a result, the economizer increases refrigeration effect and cycle efficiency.

Ball-type float valves — These valves provide precise refrigerant metering at any load. As a result, optimal refrigerant levels can be maintained in the condenser and cooler to achieve the greatest efficiency without gas bypass or flooding.

Bolt-on covers — These covers allow access to the float valves to facilitate inspection.

Storage tank — This tank is sized so that the entire refrigerant charge occupies no more than 90% of the tank volume at 90 F (32 C). This feature reduces service worktime, minimizes downtime, eliminates the additional space required for a separate tank, and eliminates the need for costly field-erected transfer piping.

Isolating valves — These valves isolate the integrated economizer/storage vessel from the condenser, cooler, and compressor during pumpout and servicing.

Microprocessor controls feature:

Direct digital Product Integrated Control (PIC) — The PIC provides unmatched flexibility and functionality. Each unit integrates directly with the Carrier Comfort Network (CCN) providing a system solution to controls applications.

Local Interface Device (LID) — This device, which can be configured to display in either English or metric units, provides unparalleled ease of human interface. A 16-line by 40-character LCD (liquid crystal display) features 4 menu-specific softkeys. The default display offers ''all in one glance'' access to key chiller operating data, simplifying machine-user interface.

Optional modules — These modules offer control expandability by allowing chilled water reset and demand limit set points to be controlled from remote sources. Optional temperature sensors can also be connected and then monitored by these modules.

Modular pull-out/plug-in design — Plug design reduces wiring requirements for easy installation.

Low-voltage design — The Class 2 control center design provides the ultimate assurance of personal safety and control integrity.

Over 100 PIC monitoring functions and conditions — PIC displays over 125 operating, state, and diagnostic messages for improved user interface.

Battery backup — Battery backup provides protection during power failures and eliminates time consuming control reconfiguration.

Extensive service menu — The service menu can be password-protected to prevent unauthorized access. Built-in diagnostic capabilities aid troubleshooting and recommend proper corrective action for pre-set alarms, resulting in greater uptime. The control test allows the user to confirm operation of inputs and outputs for increased confidence.

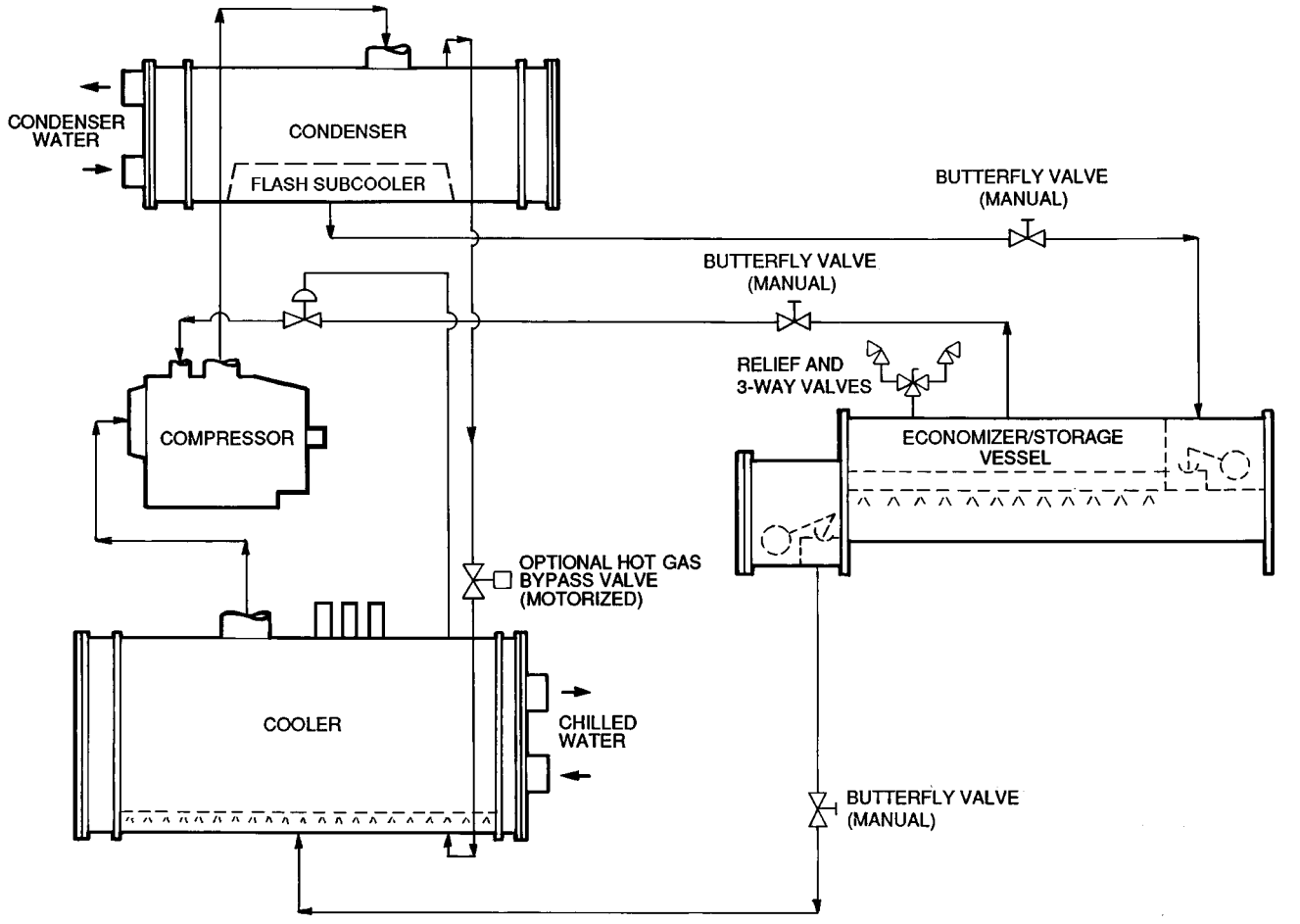
Automatic capacity override — This function unloads the compressor whenever key safety limits are approached, increasing unit life.

Encapsulated circuit board — Designed and built in-house, each board must meet Carrier's stringent quality standards resulting in superior reliability compared to open board designs.

17EX refrigeration cycle

The chiller compressor continuously draws large quantities of refrigerant vapor from the cooler at a rate determined by the amount of guide vane opening. This compressor suction reduces the pressure within the cooler and causes the remaining refrigerant to boil vigorously at a low temperature, typically 35 to 40 F (2 to 4 C).

TYPICAL 17EX REFRIGERATION CYCLE



Heat supplies the energy required for boiling and is obtained from the water (or brine) flowing through the cooler tubes. When heat is removed, the chilled water can then be used for air conditioning or for process liquid cooling.

After removing heat from the water, the refrigerant vapor passes through the compressor's first stage, is then compressed, and moves into the compressor's second stage. In the second stage it is mixed with flash-economizer gas and is further compressed.

Compression raises the refrigerant temperature above the temperature of the water currently flowing through the condenser tubes. When the warm (typically 130 F to 160 F [54 C to 71 C]) refrigerant is discharged into the condenser, the relatively cool condensing water removes some of the heat, and the refrigerant vapor condenses to a liquid.

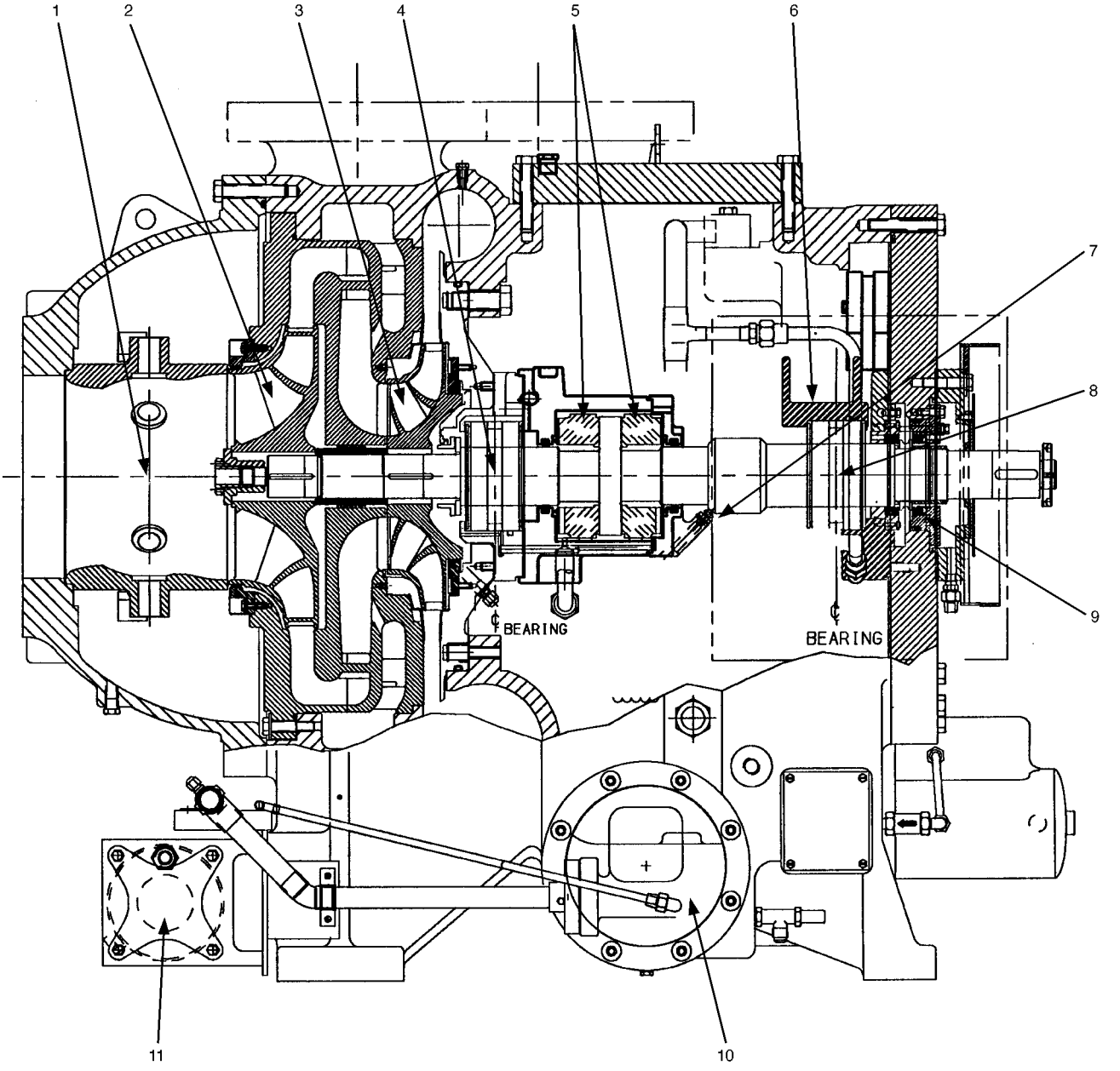
In some chillers, further removal of heat occurs in the flash subcooler at the bottom of the condenser. The liquid refrigerant passes through orifices into the flash subcooler chamber. Since the flash subcooler chamber is at a lower pressure, part of the liquid refrigerant flashes to vapor, thereby cooling the remaining liquid refrigerant. The vapor in the flash subcooler is recondensed on the tubes which are cooled by the entering condenser water.

The liquid refrigerant drains into the flash economizer/storage vessel where a valve system maintains intermediate pressure between the condenser and the cooler pressure. At this lower pressure, part of the liquid refrigerant flashes to a gas, thus cooling the remaining liquid. The flash gas is returned directly to the compressor. Here it is mixed with gas already compressed by the first-stage impeller. Since the economizer gas has to pass through only half of the compression cycle to reach condenser pressure, power is saved; hence the term ''economizer.''

The cooled liquid refrigerant in the economizer is metered through the low-side float chamber to the cooler. Since cooler pressure is lower than the economizer pressure, some of the liquid refrigerant flashes to gas and cools the remaining refrigerant to the cooler temperature. The cycle is now complete.

Three manual butterfly valves isolate the refrigerant charge in the economizer/storage vessel during chiller service.

TYPICAL OPEN-DRIVE COMPRESSOR COMPONENTS



LEGEND

1 — Variable Inlet Guide Vanes (Hidden)
2 — First-Stage Impeller
3 — Second-Stage Impeller
4 — Front Journal Bearing
5 — Thrust Bearing Assembly
6 — Coast-Down Reservoir
7 — Shaft Displacement Detector
8 — Rear Journal Bearing
9 — Contact Seal
10 — Compressor Oil Pump
11 — Compressor Oil Cooler/Filter

Options and accessories

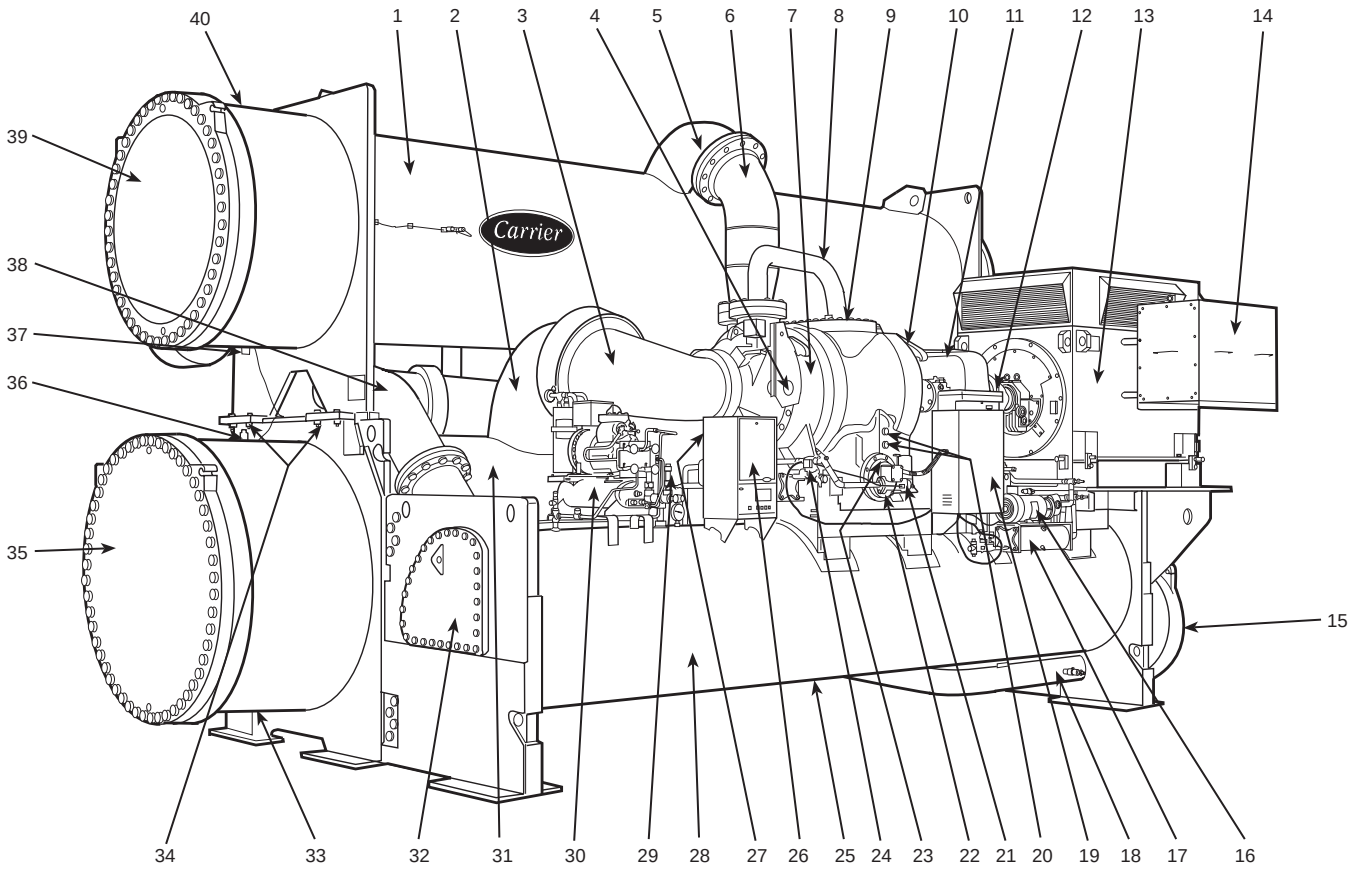
ITEM	OPTION*	ACCESSORY†
Thermal Insulation	X	
Multi-Pass Heat Exchangers	X	
Automatic Hot Gas Bypass	X	
Controls Option Module	X	
.028 or .035-in. Wall Copper Tubes, Internally Enhanced, Cooler or Condenser	X	
.028 or .035-in. Wall Copper Tubes, Smooth Bore, Cooler or Condenser	X	
.028 or .035-in. Wall 90/10 CuNi Tubes, Internally Enhanced, Cooler or Condenser	X	
.028 or .035-in. Wall 90/10 CuNi Tubes, Smooth Bore, Cooler or Condenser	X	
.025 or .028-in. Wall Tubes, Titanium, Internally Enhanced, Condenser	X	
.028-in. Wall Tubes, Titanium, Smooth Bore, Condenser	X	
Hinged Waterbox Covers	X	
Nozzle-In-Head, 300 psig (2068 kPa)	X	
Marine Waterboxes, 150 psig (1034 kPa)	X	
Marine Waterboxes, 300 psig (2068 kPa)	X	
Flanged Water Nozzles, Cooler and/or Condenser	X	
Factory Performance Test	X	
Pumpout System	X	
Motor Enclosures (WP-II, TEWAC)	X	
Motor Bearing Resistance Temperature Detectors (RTDs)	X	
Shipped Factory Charged with Refrigerant	X	
Flow Switches		X
Soleplate Package		X
Spring Isolators		X
Spare Sensors with Leads		X
Sound Insulation Kit		X
Control Options Module Upgrade Kit		X

LEGEND

TEWAC — Totally Enclosed Water-to-Air Cooled
WP-II — Weather Protected; Type II

*Factory installed. †Field installed.

Chiller components



17EX WITH EXTERNAL GEAR (SPEED INCREASER)

LEGEND

1 — Condenser
2 — Cooler Suction Pipe
3 — Compressor Suction Elbow
4 — Guide Vane Actuator
5 — Condenser Discharge Pipe
6 — Compressor Discharge Elbow
7 — Two-Stage Compressor
8 — Economizer Gas Line to Compressor
9 — Compressor Housing Access Cover
10 — High-Speed Coupling (Hidden)
11 — External Gear (Speed Increaser)
12 — Low-Speed Coupling (Hidden)
13 — Open-Drive Compressor Motor
14 — Compressor Motor Terminal Box
15 — Low-Side Float Box Cover
16 — Gear Oil Pump
17 — Gear Oil Cooler/Filter
18 — Refrigerant Liquid Line to Cooler
19 — Power Panel
20 — Oil Level Sight Glasses (2)
21 — Oil Drain and Charging Valve
22 — Oil Heater (Hidden)
23 — Compressor Oil Pump
24 — Compressor Oil Cooler/Filter
25 — Refrigerant Charging/Service Valve (Not Shown)
26 — Local Interface Display Control Panel
27 — Cooler Relief Valves (Not Shown)
28 — Economizer Storage Vessel
29 — Economizer/Storage Vessel Relief Valves
30 — Pumpout Unit
31 — Cooler
32 — High Side Float Box Cover
33 — Cooler Waterbox Drain
34 — Take-Apart Connections
35 — Cooler Marine Waterbox
36 — Cooler Waterbox Vent
37 — Condenser Waterbox Drain
38 — Refrigerant Liquid Line to Economizer/Storage Vessel
39 — Condenser Marine Waterbox
40 — Condenser Waterbox Vent

Physical data

RIGGING AND OPERATING WEIGHTS

17EX HEAT EXCHANGER, ECONOMIZER/STORAGE VESSEL, PIPING, AND PUMPOUT UNIT WEIGHTS*

COOLER SIZE†	COOLER TOTAL WEIGHT				COOLER CHARGE				ECONOMIZER/ STORAGE VESSEL		ECONOMIZER REFRIGERANT		MISCELLANEOUS PIPING		PUMPOUT UNIT	
	Dry**		Operating††		Refrigerant		Water									
	lb	kg	lb	kg	lb	kg	lb	kg	lb	kg	lb	kg	lb	kg	lb	kg
45	25,032	11 355	30,098	13 652	2,060	934	3,006	1 364	7,900	3 583	840	318	1,149	521	210	95
46	25,529	11 580	30,881	14 008	2,160	980	3,192	1 448								
47	26,025	11 805	31,663	14 362	2,260	1 025	3,378	1 532								
48	28,153	12 770	34,866	15 815	2,540	1 152	4,173	1 893								

CONDENSER SIZE†	CONDENSER TOTAL WEIGHT				CONDENSER CHARGE			
	Dry**		Operating††		Refrigerant		Water	
	lb	kg	lb	kg	lb	kg	lb	kg
45	16,676	7 564	20,596	9 342	1,200	544	2,720	1 234
46	17,172	7 789	21,280	9 653	1,200	544	2,908	1 319
47	17,669	8 015	21,965	9 963	1,200	544	3,096	1 404
55	20,725	9 401	25,598	11 611	1,420	644	3,453	1 566
56	21,663	9 826	26,891	12 198	1,420	644	3,808	1 727
57	22,446	10 182	27,971	12 688	1,420	644	4,105	1 862

*If a chiller configuration other than 2-pass, 150 psig (1034 kPa), NIH waterbox configuration is used, refer to the Additional Cooler Weights or Additional Condenser Weights table on pages 10 and 11 to obtain the additional dry and water weights that must be added to the values shown in this table.

†Cooler and condenser weights shown are based on 2-pass, nozzle-in-head (NIH) waterboxes with 150 psig (1034 kPa) covers. Includes components attached to cooler, but does not include suction/discharge, elbow, or other interconnecting piping.

**Dry weight includes all components attached to economizer: covers, float valves, brackets, control center (31 lb [14 kg]), and power panel (20 lb [9 kg]). Dry weight does not include compressor weight, motor weight, or pumpout condensing unit weight. The pumpout condensing unit weight is 210 lb (95 kg). For compressor and motor weights, refer to Compressor/Motor/Suction Elbow Weights table on page 11.

††Operating weight includes dry weight, refrigerant weight, and water weight.

ADDITIONAL COOLER WEIGHTS*

COOLER SIZES	WATERBOX TYPE	NUMBER OF PASSES	DESIGN MAXIMUM WATER PRESSURE		ADDITIONAL DRY WEIGHT		ADDITIONAL WATER WEIGHT	
			psig	kPa	lb	kg	lb	kg
45, 46, 47, 48	NIH	1, 3	150	1034	515	234	—	—
	NIH	1, 3	300	2068	2941	1334	—	—
	NIH	2	300	2068	2085	946	—	—
	Marine	1, 3	150	1034	2100	953	5102	2314
	Marine	2	150	1034	792	359	2551	1157
	Marine	1, 3	300	2068	3844	1744	5102	2314
	Marine	2	300	2068	2536	1150	2551	1157

NIH — Nozzle-In-Head

*When using a chiller configuration other than 2-pass, NIH waterboxes with 150 psig (1038 kPa) covers, add the weights listed in this table to the appropriate weights in the 17EX Heat Exchanger, Economizer/Storage Vessel, Piping, and Pumpout Unit Weights table above to obtain the correct cooler weight.

RIGGING AND OPERATING WEIGHTS (cont)

ADDITIONAL CONDENSER WEIGHTS*

COMPONENT	HEAT EXCHANGER SIZE	WATERBOX TYPE	NUMBER OF PASSES	DESIGN MAXIMUM WATER PRESSURE		ADDITIONAL DRY WEIGHT		ADDITIONAL WATER WEIGHT	
				psig	kPa	lb	kg	lb	kg
CONDENSER	45 - 47	NIH	1, 3	150	1034	344	156	—	—
		NIH	1, 3	300	2068	1652	749	—	—
		NIH	2	300	2068	1132	513	—	—
		Marine	1, 3	150	1034	1692	767	3 400	1 542
		Marine	2	150	1034	674	306	1 700	771
		Marine	1, 3	300	2068	2651	1 202	3 400	1 542
		Marine	2	300	2068	1630	739	1 700	771
	55 - 57	NIH	1	150	1034	†	†	—	—
		NIH	1	300	2068	1588	720	—	—
		NIH	2	300	2068	1591	721	—	—
		Marine	2	150	1034	25	11	1 734	787
		Marine	2	300	2068	1225	555	1 734	787

NIH — Nozzle-In-Head

*When using a chiller configuration other than 2-pass, NIH waterboxes with 150 psig (1034 kPa) covers, add the weights listed in this table to the appropriate weights in the 17EX Heat Exchanger, Economizer/Storage Vessel, Piping, and Pumpout Unit Weights table on page 10 to obtain the correct condenser weight.

†Subtract 228 lb (103 kg) from the rigging weight shown in 17EX Heat Exchanger, Economizer/Storage Vessel, Piping, and Pumpout Unit Weights table on page 10.

COMPRESSOR/MOTOR/SUCTION ELBOW WEIGHTS

(ALL COMPRESSOR SIZES)

ENGLISH (lb)	SI (kg)
18,497*	8 384†

*Based on 6900 v, FK motor.
†Based on 6300 v, FK motor.

MARINE WATERBOX COVER WEIGHTS*

HEAT EXCHANGER SIZE	DESIGN MAXIMUM WATER PRESSURE		COOLER		CONDENSER	
	psi	kPa	lb	kg	lb	kg
45 - 48	150	1034	2236	1015	1275	579
	300	2068	3060	1389	1660	754
55 - 57	150	1034	—	—	1643	746
	300	2068	—	—	2243	1018

*Heat exchangers with marine waterboxes have heavier dry and operating weights than heat exchangers with nozzle-in-head waterboxes.

NIH WATERBOX COVER WEIGHTS*

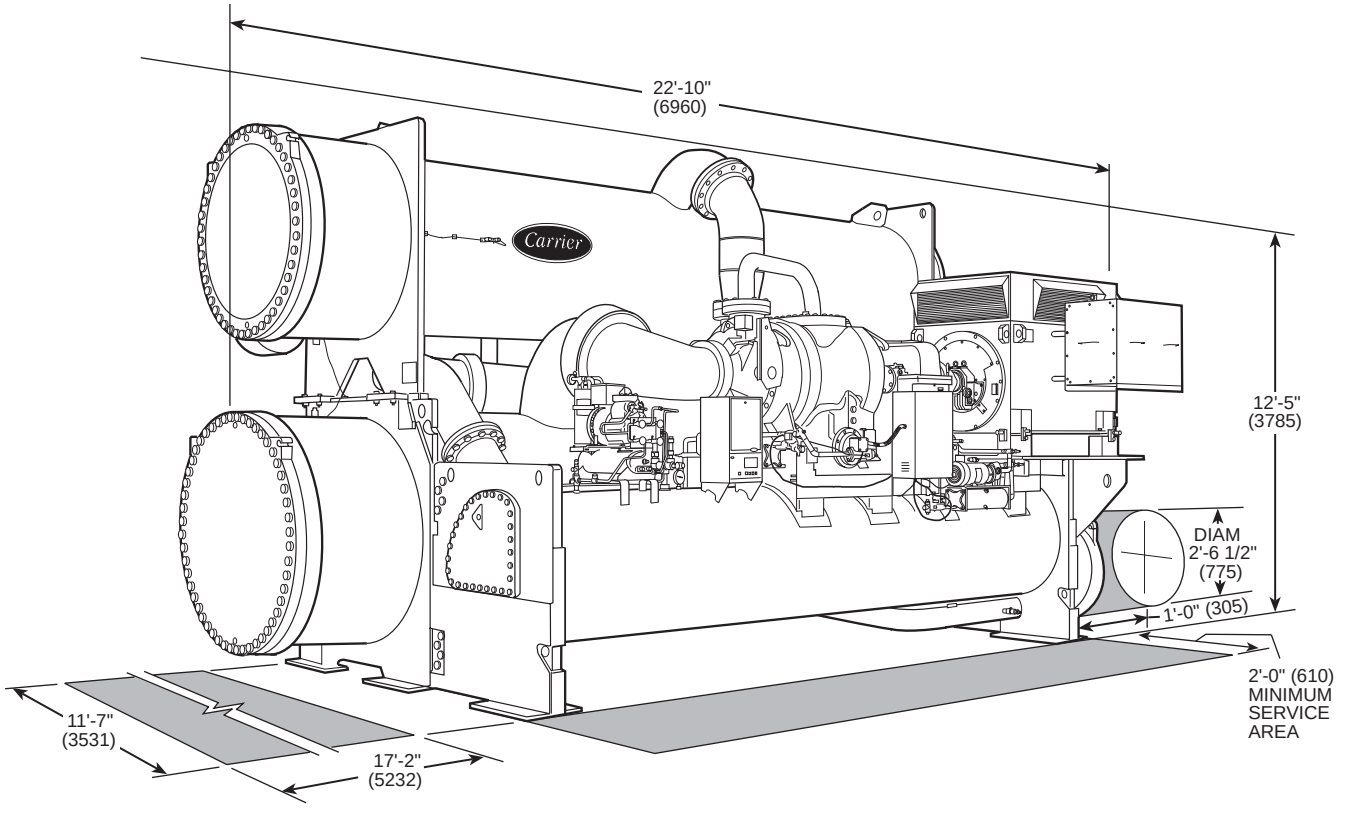
HEAT EXCHANGER SIZE	PASSES	DESIGN MAXIMUM WATER PRESSURE		COOLER		CONDENSER	
		psi	kPa	lb	kg	lb	kg
45 - 48	1	150	1034	2997	1361	1735	788
		300	2068	4225	1918	2510	1140
	2†	150	1034	2984	1355	1885	856
		300	2068	4188	1901	2590	1176
	3	150	1034	3035	1378	1777	807
		300	2068	4244	1927	2539	1153
55 - 57	1	150	1034	—	—	2032	923
		300	2068	—	—	2940	1335
	2†	150	1034	—	—	2649	1203
		300	2068	—	—	3640	1653
	3	150	1034	—	—	—	—
		300	2068	—	—	—	—

NIH — Nozzle-in-Head

*The 150 psig (1034 kPa) waterbox cover weights are included in the dry weight shown in the 17EX Heat Exchanger, Economizer/Storage Vessel, Piping, and Pumpout Unit Weights table on page 10.

†Two different waterbox covers are present on 2-pass chillers. The weight shown in this table represents the weight of the waterbox cover that contains the nozzles. A blank waterbox cover is also present on 2-pass units. The weight of the blank waterbox cover is identical to the weight of the same size marine waterbox cover. Refer to the Marine Waterbox Cover Weights table above.

Dimensions



NOZZLE SIZES

HEAT EXCHANGER	NOZZLE TYPE	NOZZLE SIZES (in.)					
		Cooler Passes			Condenser Passes		
		1	2	3	1	2	3
45 - 48	Marine	20	14	12	20	14	12
	NIH	18	14	10	18	12	10
55 - 57	Marine	—	—	—	—	16	—
	NIH	—	—	—	20	16	—

LEGEND

NIH — Nozzle-In-Head

*In conformance with ASA B36.10 (American Standards Association).

NOTES:
1. Certified drawings available upon request.
2. The chiller height shown is based on a condenser size 55, 56, or 57. For chillers with condenser sizes 45, 46, or 47, subtract 3 in. (76 mm) from this height.
3. Service access should be provided per American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE) 15, latest edition, National Fire Protection Association (NFPA) 70, and local safety codes.
4. Distance required for tube removal may be at either end.
5. Overall width of units will vary greatly depending on the application. See the appropriate certified drawings.
6. The table at the right provides additional information on nozzle sizes. Victaulic grooves are standard for these nozzles. Optional 150 psig (1034 kPa) and 300 psig (2068 kPa) flanges are available.

NOMINAL PIPE SIZE (in.)	SCHEDULE*	WALL THICKNESS	
		in.	mm
10	40	.365	9.27
12	Std	.375	9.53
14	30	.375	9.53
16	30	.375	9.53
18	Std	.375	9.53
20	20	.375	9.53

Performance data

Computerized ratings

Since Carrier's 17EX chiller has numerous component combinations and can meet a wide variety of required operating conditions, it is impractical to provide tabular performance information. Tabulated performance ratings predict ''typical'' chiller performance. Actual chiller performance may vary significantly at actual operating conditions and as chiller components are optimized around these conditions.

Computerized performance ratings are available through your local Carrier sales representative. These ratings are custom matched to meet project-specific operating conditions and energy efficiency requirements.

ARI Certification Program

The computerized performance ratings of the Carrier 17EX chiller are certified by the Air Conditioning and Refrigeration Institute (ARI). The Certification Program requires that the manufacturer's ratings be regularly checked for accuracy through a program of chiller testing in strict compliance with ARI Standard 550. This independent verification provides assurance of chiller performance.

Part-load performance

Frequently, a chiller will operate at part-load for the majority of its total operating hours. In some cases, a chiller with better part-load performance offers an annualized operating cost advantage over one that performs less efficiently at lower loads.

Established by ARI, the Integrated Part-Load Value (IPLV) is a weighted average of kW/ton values over a wide range of chiller operation. IPLV is a convenient way to compare the part-load performance of different chillers under standardized typical conditions. The IPLV rating method has been incorporated into the ARI Certification Program. The 17EX chiller computerized ratings are certified in accordance with this program.

Variables such as local weather data, building load profiles, and local utility rate structures may significantly alter the impact of part-load performance on actual operating cost. Any operating cost analysis should include all factors relevant to a particular application.

Electrical data

AUXILIARY RATINGS

POWER SOURCE	ITEM	AVERAGE kW	DESIGN CENTER VOLTAGE	SUPPLY V-PH-Hz	FLA	LRA
1	Seal Leakage Pump	0.23	115	115-1-50/60	4.78	21.7
	Motor Space Heater	0.50	115	115-1-50/60	4.35	4.35
	Control Module and Actuator	0.40	115	115-1-60 115-1-50	3.50	—
	Oil Sump Heater	1.00	115	115-1-60 115-1-50	8.70	—
1*	Hot Gas Bypass	0.20	115	115-1-50/60	2.00	4.75
2†	Compressor Oil Pump	0.66	220 430 563	200/240-3-60 380/480-3-60 507/619-3-60	4.32 2.15 2.13	24.5 12.2 25.0
			230 393	220/240-3-50 346/440-3-50	4.83 2.59	28.0 12.2
3†	Gear Oil Pump	0.7	204 220 460 575	200/208-3-60 208/230-3-60 440/480-3-60 518/632-3-60	5.7 4.2 2.1 1.7	33.5 30.6 15.3 12.3
			205 410	190/220-3-50 380/440-3-50	5.0 2.5	28.9 14.5
4*	Pumpout Compressor	3.41	204 230 460 575	200/208-3-60 220/240-3-60 440/480-3-60 550/600-3-60	10.90 9.50 4.70 3.80	63.5 57.5 28.8 23.0
			400	380/415-3-50	4.70	28.8

LEGEND

FLA — Full Load Amps
LRA — Locked Rotor Amps

*Available as an option on 17EX chillers.
†When possible, it may be beneficial to use the compressor oil pump power source as the gear oil pump power source.

NOTE: The oil pump is powered through a field wiring terminal into the power panel. Power to the controls and oil heater via the power panel must be on circuits that can provide continuous service when the compressor starter is disconnected.

Electrical data (cont)

Compressor motor controllers

Compressor motors, as well as controls and accessories, require starting equipment systems specifically designed for 17 series chillers. See starting equipment publications or consult Carrier regarding design information for selection of controllers.

Capacitors and power factors

Power factor considerations may indicate the need to use capacitors. Properly sized capacitors improve power factors, especially at part-load. Contact your local Carrier sales office for further information on power factors.

60 Hz MOTOR DATA

MOTOR SIZE*	MOTOR HP	MAXIMUM kW	FLA/LRA	MOTOR VOLTAGE			
				2400 V	3300 V	4160 V	6900 V
FA, HA, JA, FF, HF, JF	1250	968	FLA per kW	0.264	0.192	0.152	0.092
			LRA delta	1777	1290	1027	628
FB, HB, JB, FG, HG, JG	1500	1160	FLA per kW	0.261	0.190	0.151	0.091
			LRA delta	2060	1532	1190	718
FH, HH, JH	1600	1237	FLA per kW	0.265	0.193	0.154	0.093
			LRA delta	2302	1532	1330	806
FC, HC, JC, FJ, HJ, JJ	1750	1353	FLA per kW	0.261	0.190	0.151	0.092
			LRA delta	2544	1532	1470	893
FD, HD, JD, FK, HK, JK	2000	1543	FLA per kW	0.262	0.191	0.151	0.093
			LRA delta	2537	2006	1466	998

LEGEND

FLA per kW — Full Load Amps per kW Input
LRA — Locked Rotor Amps

*The first letter of the 2-letter motor designation indicates the motor enclosure. The enclosures and their associated designations are:

F — ODP (Open Drip Proof)
H — WP-II (Weather Protected, Type II)
J — TEWAC (Totally Enclosed Water-To-Air Cooled)

†Listed motor voltages are design voltages. Motors are suitable for use with supply voltages as noted and will operate satisfactorily at 10% below the minimum and at 10% above the maximum supply voltage.

2400 v — for use on 2300- to 2500-v systems
3300 v — for use on 3150- to 3450-v systems
4160 v — for use on 4000- to 4300-v systems
6900 v — for use on 6600- to 7200-v systems

50 Hz MOTOR DATA

MOTOR SIZE*	MOTOR HP	MAXIMUM kW	FLA/LRA	MOTOR VOLTAGE		
				3000 V	3300 V	6300 V
FA, HA, JA FF, HF, JF	1250	969	FLA per kW	0.209	0.193	0.103
			LRA delta	1176	1320	690
FB, HB, JB, FG, HG, JG	1500	1162	FLA per kW	0.209	0.194	0.102
			LRA delta	1439	1619	791
FH, HH, JH	1600	1236	FLA per kW	0.213	0.197	0.104
			LRA delta	1521	1710	853
FC, HC, JC, FJ, HJ, JJ	1750	1352	FLA per kW	0.209	0.193	0.101
			LRA delta	1602	1801	915
FD, HD, JD, FK, HK, JK	2000	1544	FLA per kW	0.210	0.192	0.102
			LRA delta	1812	1902	1010

LEGEND

FLA per kW — Full Load Amps per kW Input
LRA — Locked Rotor Amps
OLTA — Overload Trip Amps

*The first letter of the 2-letter motor designation indicates the motor enclosure. The enclosures and their associated designations are:

F — ODP (Open Drip Proof)
H — WP-II (Weather Protected, Type II)
J — TEWAC (Totally Enclosed Water-To-Air Cooled)

†Listed motor voltages are design voltages. Motors are suitable for use with supply voltages as noted and will operate satisfactorily at 10% below the minimum and at 10% above the maximum supply voltage.

3000 v — for use on 2900- to 3100-v systems.
3300 v — for use on 3200- to 3400-v systems
6300 v — for use on 6000- to 6600-v systems

NOTE: To establish electrical data for your selected voltage, if other than listed voltage, use the following formulas:

$$\text{Motor FLA} = \text{listed FLA per kW} \times \frac{\text{listed voltage}}{\text{selected voltage}}$$

$$\text{OLTA} = 1.08 \times \text{corrected FLA}$$

$$\text{LRA} = \text{listed LRA per kW} \times \frac{\text{selected voltage}}{\text{listed voltage}}$$

EXAMPLE: Find the full load amperage for a motor listed at 0.261 amps per kW input and 2300 volts.

$$\text{FLA} = 0.261 \times \frac{2400}{2300} = 0.272 \ \frac{\text{FLA}}{\text{kW}}$$

Application data

Range of application

The 17EX chiller is designed for standard water (or brine) chilling applications using HFC-134a.

ASME stamping

All 17EX heat exchangers are constructed in accordance with ASHRAE 15 (American Society of Heating, Refrigeration, and Air Conditioning Engineers) Safety Code for Mechanical Refrigeration (latest edition). This code, in turn, requires conformance with ASME (American Society of Mechanical Engineers) Code for Unfired Pressure Vessels whenever applicable. As a consequence, all 17EX heat exchangers are affixed with an ASME ''U'' stamp on both the water side and the refrigerant side to certify compliance with ASME Section VIII, Division 1 Code for Unfired Pressure Vessels.

Design pressure

Design and test pressures for 17EX heat exchangers are listed below.

DESIGN AND TEST PRESSURES

COMPONENT	DESIGN		HYDROSTATIC		AIR TEST	
	psi	kPa	psi	kPa	psi	kPa
SHELL SIDE (Refrigerant) Cooler	225	1551	—	—	281	1937
Condenser	225	1551	—	—	281	1937
TUBE SIDE* (Water) Cooler	150	1034	225	1551	—	—
Condenser	150	1034	225	1551	—	—
Economizer/ Storage Vessel	225	1551	—	—	281	1937

*Indicates 150 psig (1034 kPa) waterside construction.

HEAT EXCHANGER MATERIAL SPECIFICATIONS

COMPONENT	MATERIAL	SPECIFICATION
Shell Tube Sheet Waterbox Cover Waterbox Shell	HR Steel	ASME SA516 Gr70
Tubes	Finned Copper	ASME SB359
Discharge/Suction	Steel Pipe	ASME SA106 GrA
	Pipe Fittings	ASME SA105
Compressor Housing	Cast Iron	ASTM* A159 Grade 3000

*ASTM — American Society for Testing and Materials.

Insulation Requirements

THERMAL INSULATION REQUIREMENTS

FOAM TUBING INSULATION

TYPE	Ft	m
1⅛″ Foam Tubing	9	2.7
1⅝″ Foam Tubing	2	0.6
2″ Foam Tubing	9	2.7
5″ Foam Tubing	14	4.3

SHEET FOAM INSULATION

COMPONENT	ft^2	m^2
Cooler Shell (Sizes 45-48)*	374	34.7
Economizer Low Side Float Chamber	48	4.5
Economizer Main Shell	115	10.1
Suction Line	25	2.3
Cooler Marine Waterbox (1 or 3 pass)	158	14.7
Cooler Marine Waterbox (2 pass)	123	11.4
Cooler NIH Waterbox	88	8.2

*The 374 sq. ft total includes 134 sq. ft of tube sheet insulation.

NOTES:
1. Cooler value includes marine waterbox on one end (even-pass arrangement).
2. Values are approximate.
3. Thermal insulation is available as a factory-installed option. Waterbox insulation must be field supplied.

Insulation at jobsite — The Condensation versus Relative Humidity table indicates the degree of surface condensation occurs for specific conditions of temperature and relative humidity. Carrier recommends that insulation be added to the cooler waterboxes (including the tube sheet) and suction elbow if the actual operating conditions cause condensation.

Insulation of the cooler waterboxes should allow for service access and removal of covers.

The recommended insulation is ¾ in. (19 mm) thick closed-cell neoprene with a thermal conductivity K value of $0.28 \frac{\text{Btu} \cdot \text{in.}}{\text{hr} \cdot \text{ft}^2 \cdot °\text{F}}$ $(0.0404 \frac{\text{W}}{\text{m}}$ °C). Insulation should conform with UL (Underwriters' Laboratories) Standard 94 and have classification 94 HBF.

Factory insulation (optional) — Optional factory insulation is available for the evaporator shell and tube sheets, suction pipe, compressor motors, economizer low side, and refrigerant drain line(s). Insulation applied at the factory is ¾ in. (19 mm) thick and has a thermal conductivity K value of $0.28 \frac{\text{Btu} \cdot \text{in.}}{\text{hr} \cdot \text{ft}^2 \cdot °\text{F}}$ $(0.0404 \frac{\text{W}}{\text{m}}$ °C). Insulation conforms with UL Standard 94, Classification 94 HBF.

CONDENSATION VS RELATIVE HUMIDITY*

AMOUNT OF CONDENSATION	ROOM DRY-BULB TEMP					
	80 F	(27 C)	90 F	(32 C)	100 F	(38 C)
	% Relative Humidity					
None	80		76		70	
Slight	87		84		77	
Extensive	94		91		84	

*These approximate figures are based on 35 F (1.7 C) saturated suction temperature. A 2 F (1.1 C) change in saturated suction temperature changes the relative humidity values by 1% in the same direction.

Application data (cont)

Vent and drain connections

All vent and drain connections are found in the waterbox shell. Vent and drain connection size is 1-in. FPT.

Provide the high points of the chiller piping system with vents and the low points with drains. If shutoff valves are provided in the main water pipes near the unit, a minimum amount of system water is lost when the heat exchangers are drained. This reduces the time required for drainage and saves on the cost of re-treating the system water.

It is recommended that pressure gages be provided at points of entering and leaving water to measure pressure drop through the heat exchanger. Gages may be installed as shown in the Pressure Gage Location table. Pressure gages installed in the vent and drain connections do not include nozzle pressure losses.

Use a reliable manometer to measure pressure differential when determining water flow. Regular gages are insensitive and do not accurately measure flow conditions.

PRESSURE GAGE LOCATION

NUMBER OF PASSES	GAGE LOCATION (Cooler or Condenser)
1 and 3	One gage in each waterbox.
2	Two gages in waterbox with nozzles.

Refrigerant temperature sensors

All 17EX chillers are supplied with cooler and condenser temperature sensors.

Thermometers

Recommended ranges for thermometers are:

Entering and leaving chilled water/brine, 20 F to 80 F (–7 to 27 C);

Entering and leaving condenser water, 30 F to 120 F (–1 to 49 C)

Thermometers for measuring chilled water and condensing water temperatures are field purchased, as required, for individual jobs. It is recommended that thermometer wells be provided in cooler and condenser water piping. Wells in the leaving water pipes should be 6 to 10 pipe diameters from the waterboxes. This provides sufficient distance for complete mixing of water as it leaves the heat exchanger tubes. Extend thermometers into the pipe at least 2 in. (51 mm).

Relief devices

The 17EX chiller is equipped with standard relief valves. The quantity of devices and the outlet connection size of each valve is listed in the Relief-Valve Discharge Piping Data table below.

Relief-valve discharge piping sizing should be calculated per the current version of the ASHRAE 15 code using the tabulated C-factors in the Relief-Valve Discharge Piping table shown below.

Carrier further recommends that a refrigerant sensor or an oxygen deprivation sensor be installed to protect personnel. The oxygen deprivation sensor should be the type that senses the depletion or displacement of oxygen in the machine room below 19.5% volume oxygen per ASHRAE 15, latest edition.

AUXILIARY CONNECTIONS

SIZE AND STYLE	USAGE
½ in. NPT Conduit	Power Panel Oil Pump Power Connection (for compressor and Gear Oil Pumps)
1¼ in. FPT	Cooler and Economizer/Storage Vessel Relief Valve Connections
¾ in. FPT	Compressor Oil Cooler Connections
¾ in. FPT	Gear Oil Cooler Connections
½ in. FPT	Pumpout Water Inlet Connection
½ in. FPT	Pumpout Water Outlet Connection
⅜ in. Male Flare	Pumpout Condenser Refrigerant Vapor Connection (Rupture Disc)
1 in. FPT	Waterbox Vent Connection
1 in. FPT	Waterbox Drain Connection

RELIEF-VALVE DISCHARGE PIPING DATA

RELIEF VALVE LOCATION	HEAT EXCHANGER SIZE		OUTLET SIZE	
	Cooler	Condenser	1¼ in. FPT	⅜ in. Male Flare
			No. of Valves	
Cooler	45-48	45-47	3	—
		55-57	3	—
Economizer/Storage Vessel	ALL	ALL	2*	—
Pumpout Unit Condenser	ALL	ALL	—	1

*To ensure relief valve serviceability, and as required in ASHRAE 15 (American Society of Heating, Refrigeration, and Air Conditioning Engineers), latest edition, three-way valves and redundant relief valves are installed on the storage vessel. Only one half of the "No. of Valves" listed are in service at any time.

RELIEF-VALVE DISCHARGE PIPING

RELIEF VALVE LOCATION	HEAT EXCHANGER SIZE		REQUIRED C FACTOR		NOMINAL OUTLET PIPE SIZE (in.)	RATED RELIEF PRESSURE	
	Cooler	Condenser	lb air/min.	kg air/sec.		psig	kPa
Cooler	45-48	45-47	216.3	1.64	1¼ FPT	225	1551
		55-57	228.5	1.73	1¼ FPT	225	1551
Economizer/Storage Vessel	45-48	ALL	84.3	0.64	1¼ FPT	225	1551
Pumpout Unit Condenser	45-48	ALL	1.5	0.01	⅜ in. Male Flare MPT	385	2655

NOTES:
1. The cooler relief C-factor is for both cooler and condenser vented through the cooler in accordance with ASHRAE 15 (American Society of Heating, Refrigeration and Air Conditioning Engineers).
2. Relief valve discharge pipe sizing is to be calculated per latest version of ASHRAE 15, using the tabulated C-factors and nominal pipe size listed above. Cooler and economizer/storage vessel rated relief valve pressure is 225 psig (1551 kPa).
3. The pumpout unit condenser contains less than 110 lb (50 kg) of HFC-134a, which is a Group A1 refrigerant. The ASHRAE 15 standard exempts small-volume vessels from the requirement to vent outside. However, Carrier recommends that the pumpout condenser be connected to the rest of the vent system.

HEAT EXCHANGER MINIMUM/MAXIMUM FLOW RATES*

ENGLISH (Gpm)

FRAME SIZE	COOLER SIZE	1 PASS		2 PASS		3 PASS	
		Min	Max	Min	Max	Min	Max
4	45	2710	10,842	1355	5421	903	3614
	46	2957	11,827	1478	5914	986	3942
	47	3203	12,813	1602	6406	1068	4271
	48	4265	17,058	2132	8529	1422	5686

FRAME SIZE	CONDENSER SIZE	1 PASS		2 PASS		3 PASS	
		Min	Max	Min	Max	Min	Max
4	45	2786	11,143	1393	5572	929	3714
	46	3039	12,156	1520	6078	1013	4052
	47	3292	13,169	1646	6585	1097	4390

SI (L/sec)

FRAME SIZE	COOLER SIZE	1 PASS		2 PASS		3 PASS	
		Min	Max	Min	Max	Min	Max
4	45	171	684	85	342	57	228
	46	187	746	93	373	62	249
	47	202	808	101	404	67	269
	48	269	1076	135	538	90	359

FRAME SIZE	CONDENSER SIZE	1 PASS		2 PASS		3 PASS	
		Min	Max	Min	Max	Min	Max
4	45	176	703	88	351	59	234
	46	192	767	96	383	64	256
	47	208	831	104	415	69	277

*Flow rates are based on standard tubes in the cooler and condenser. Minimum flow based on tube velocity of 3 ft/sec (0.9 m/sec); maximum based on 12 ft/sec. (3.6 m/sec).

Application data (cont)

HEAT EXCHANGER MINIMUM/MAXIMUM FLOW RATES* (cont)

ENGLISH (Gpm)

FRAME SIZE	CONDENSER SIZE	1 PASS		2 PASS		3 PASS	
		Min	Max	Min	Max	Min	Max
5	55	3660	14,640	1830	7320	N/A	N/A
	56	4091	16,364	2045	8182	N/A	N/A
	57	4511	18,042	2255	9021	N/A	N/A

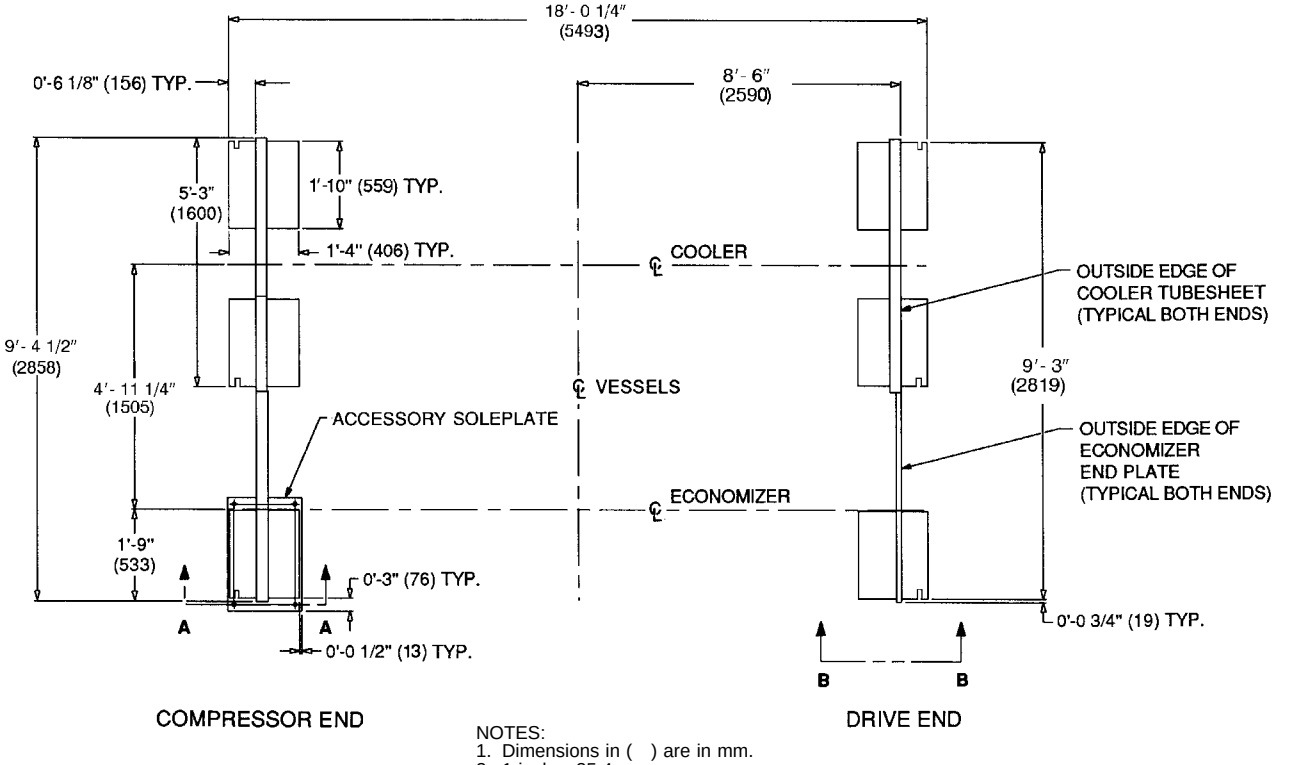
SI (L/sec)

FRAME SIZE	CONDENSER SIZE	1 PASS		2 PASS		3 PASS	
		Min	Max	Min	Max	Min	Max
5	55	231	924	115	462	N/A	N/A
	56	258	1032	129	516	N/A	N/A
	57	285	1138	142	569	N/A	N/A

*Flow rates are based on standard tubes in the cooler and condenser. Minimum flow based on tube velocity of 3 ft/sec (0.9 m/sec); maximum based on 12 ft/sec. (3.6 m/sec).

CHILLER CONTACT SURFACES

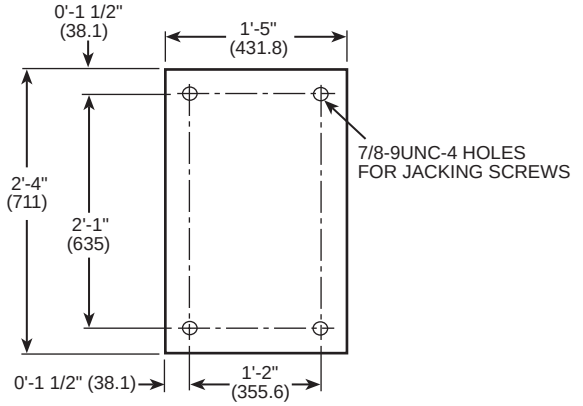
COOLER SIZES 45-48



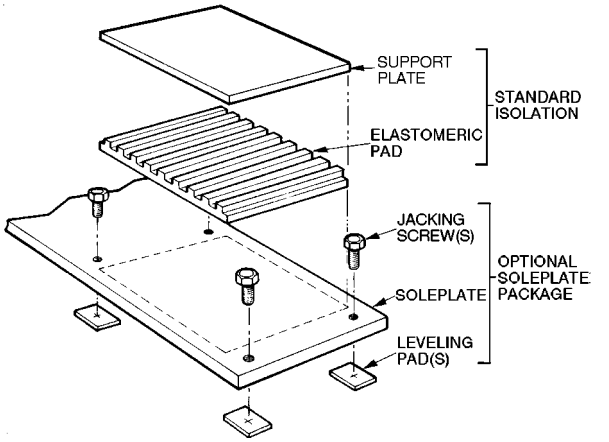
NOTES:
1. Dimensions in ( ) are in mm.
2. 1 inch = 25.4 mm.
3. All dimensions approximately ± ½ inch.

CHILLER CONTACT SURFACES (cont)

SOLEPLATE ISOLATION

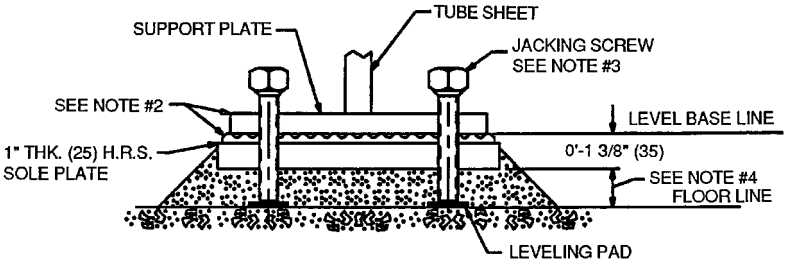


TYPICAL ISOLATION



FIELD-INSTALLED ACCESSORY ISOLATION

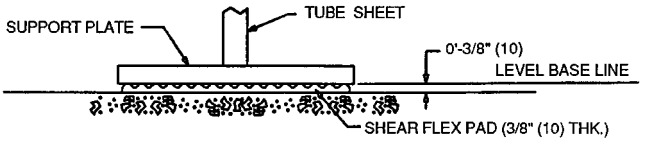
SOLEPLATE DETAIL
SECTION A-A



NOTES:
1. Dimensions in ( ) are in millimeters.
2. Accessory Soleplate Package includes 4 soleplates, 16 jacking screws and leveling pads. Requires isolation package.
3. Jacking screws to be removed after grout has set.
4. Thickness of grout will vary, depending on the amount necessary to level chiller. Use only pre-mixed non-shrinking grout, Ceilcote HT-648 or Master Builders 636, 0′-1½″ (38.1) to 0′-2¼″ (57) thick.

STANDARD ISOLATION

VIEW B-B



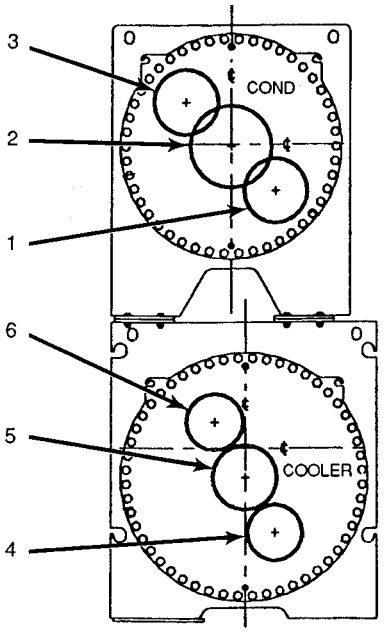
ISOLATION WITH ISOLATION PACKAGE
ONLY (STANDARD)

NOTE: Isolation package includes 4 shear flex pads.

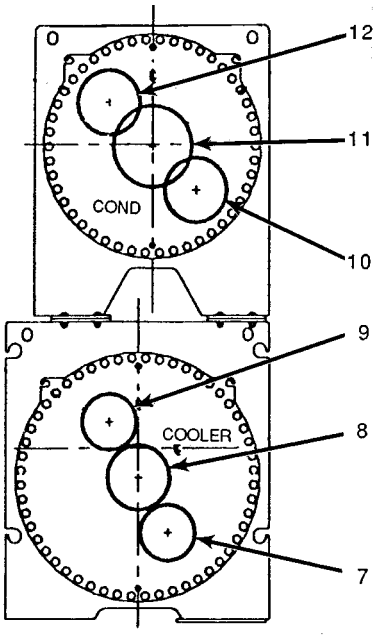
Application data (cont)

NOZZLE ARRANGEMENTS

NOZZLE-IN-HEAD WATERBOXES



COMPRESSOR END

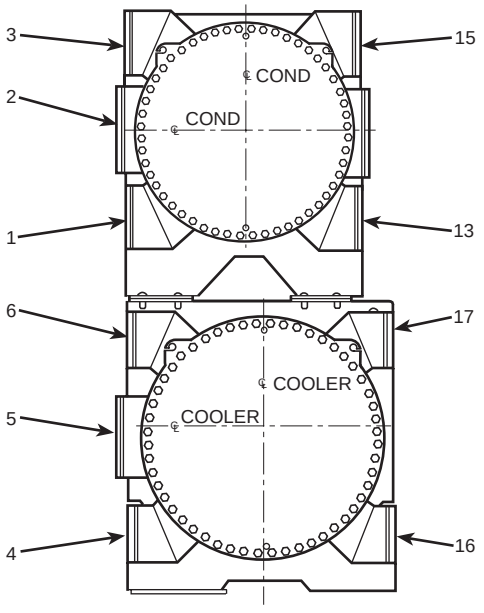


DRIVE END

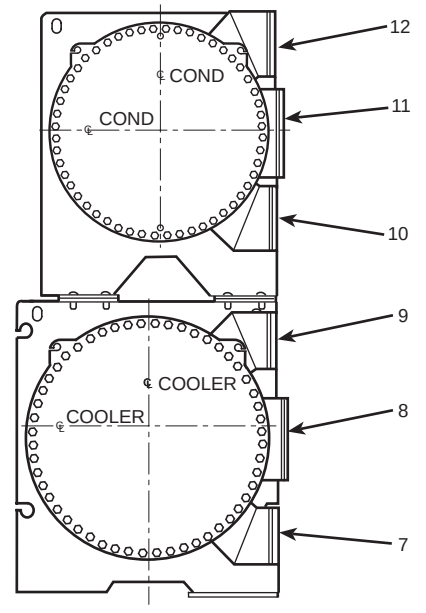
COOLER WATERBOX			
Pass	In	Out	Arr. Code
1	8	5	A
	5	8	B
2	7	9	C
	4	6	D
3	7	6	E
	4	9	F
CONDENSER WATERBOX			
Pass	In	Out	Arr. Code
1	11	2	P
	2	11	Q
2	10	12	R
	1	3	S
3	10	3	T
	1	12	U

NOTES:
1. Frame 5 condenser available in 1 and 2 pass only.
2. The vents for these waterboxes, located in the covers are 1 in. FPT at the top of each box, and the drains are 1 in. FPT, at the bottom.
3. Victaulic connections are standard.
4. Flanged waterbox connections are optional.

MARINE WATERBOXES



COMPRESSOR END



DRIVE END

COOLER WATERBOX			
Pass	In	Out	Arr. Code
1	8	5	A
	5	8	B
2	7	9	C
	4	6	D
	16	17	G
3	7	6	E
	4	9	F
CONDENSER WATERBOX			
Pass	In	Out	Arr. Code
1	11	2	P
	2	11	Q
2	10	12	R
	1	3	S
	13	15	Y
3	10	3	T
	1	12	U

NOTES:
1. Frame 5 condenser available in 2 passes only.
2. The vents for these waterboxes are 1 in. FPT at the top of each box, and the drains are 1 in. FPT, at the bottom.
3. Victaulic connections are standard.
4. Flanged waterbox connections are optional.

Controls

Microprocessor controls

Microprocessor controls provide the safety, interlock, capacity control, and indications necessary to operate the chiller in a safe and efficient manner.

Control system

The microprocessor control on each Carrier centrifugal system is factory mounted, wired, and tested to ensure chiller protection and efficient capacity control. In addition, the program logic ensures proper starting, stopping, and recycling of the chiller and provides a communication link to the Carrier Comfort Network (CCN).

Features

Control system

Component Test and Diagnostic Check
Menu-Driven Keypad Interface for Status Display, Set Point Control, and System Configuration
CCN Compatible
Primary and Secondary Status Messages
Individual Start/Stop Schedules for Local and CCN Operation Modes
Recall of Up to 25 Alarm/Alert Messages with Diagnostic Help
Automatic 2 Chiller Lead/Lag with Integral Standby Controls
Ice Build Time Schedule/Set Point Control Soft Stop Control

Safety cutouts

Bearing Oil High Temperature*
Gear Oil High Temperature*
Motor High Temperature*†
Refrigerant (Condenser) High Pressure*†
Refrigerant (Cooler) Low Temperature*†
Compressor Lube Oil Low Pressure**
Gear Lube Oil Low Pressure*
Compressor (Refrigerant) Discharge Temperature*
Under Voltage**
Over Voltage**
Compressor Oil Pump Motor Overload
Gear Oil Pump Motor Overload
Cooler and Condenser Water Flow††
Motor Overload†
Motor Acceleration Time
Intermittent Power Loss‖
Compressor Starter Faults
Compressor Surge Protection¶

Capacity Control

Leaving Chilled Water Control
Entering Chilled Water Control
Soft Loading Control by Temperature or Load Ramping
Guide Vane Actuator Modulation
Hot Gas Bypass Valve
Power (Demand) Limiter
Automatic Chilled Water Reset

Interlocks

Manual/Automatic Remote Start
Starting/Stopping Sequence
- Pre-Lube/Post-Lube
- Pre-Flow/Post-Flow
- Compressor Oil Pump Interlock
- Gear Oil Pump Interlock
- Starter Run Interlock

Pre-Start Check of Safeties and Alerts
Low Chilled Water (Load) Recycle
Monitor/Number Compressor Starts and Run Hours
Manual Reset of Safeties
Condenser Low Pressure*

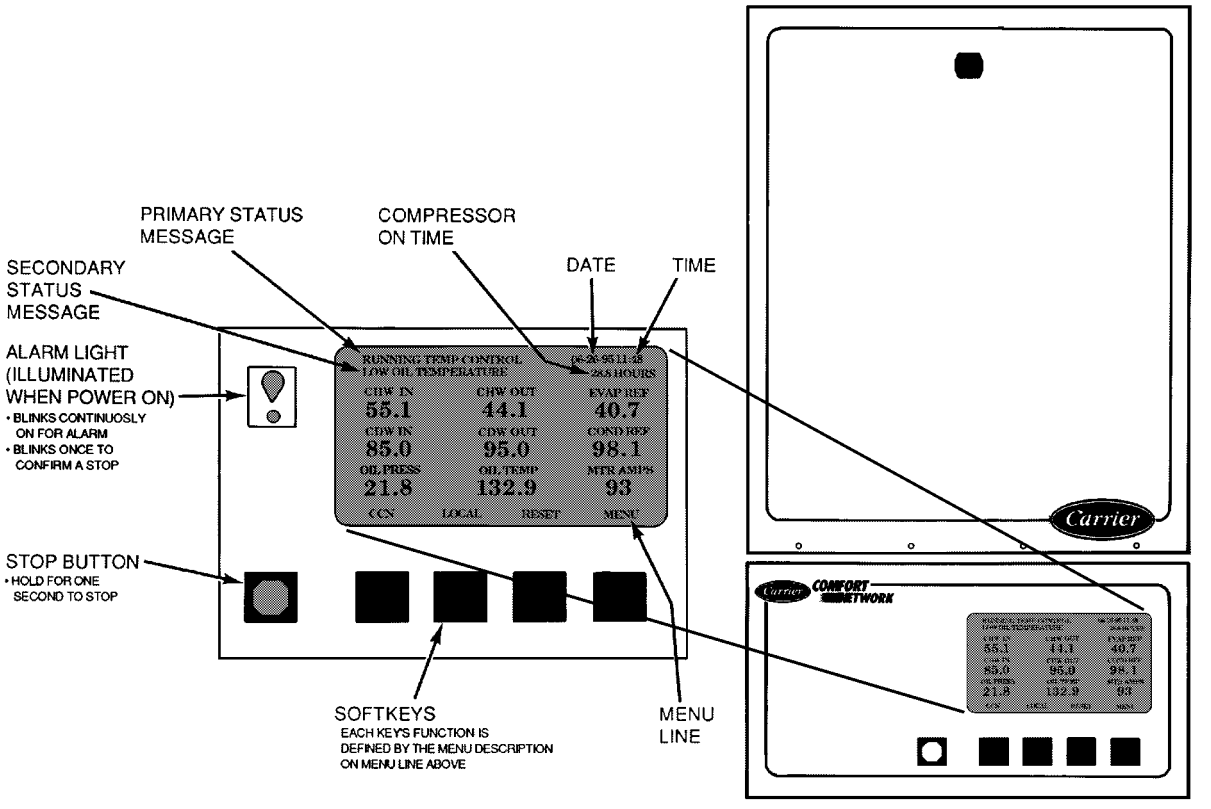
Indications

Chiller Operating Status Message
Power-On
Pre-Start Diagnostic Check
Compressor Motor Amps
Pre-Alarm Alert*
Alarm
Contact for Remote Alarm
Safety Shutdown Messages
Elapsed Time (Hours of Operation)
Chiller Input kW***

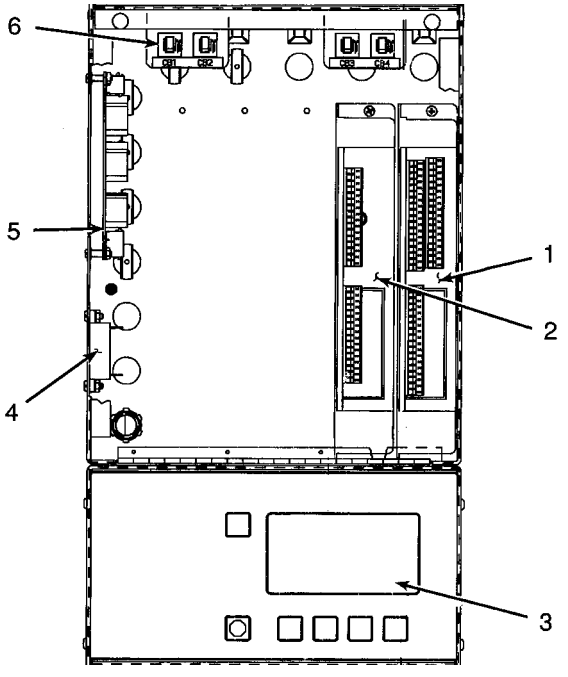
*Can be configured by the user to provide an alert indication at a user-defined limit.
†Override protection: Causes compressor to first unload and then, if necessary, shut down.
**Alert limit pre-configured. Non-adjustable.
††Required: field or factory supplied flow switch (installed at jobsite).
‖Will not require manual reset or cause an alarm if auto-restart after power failure is enabled.
¶Can be configured by the user to provide an alarm shutdown at a user-defined limit.
***kW transducer must be supplied in the motor starter.

Controls (cont)

MICROPROCESSOR CONTROL CENTER



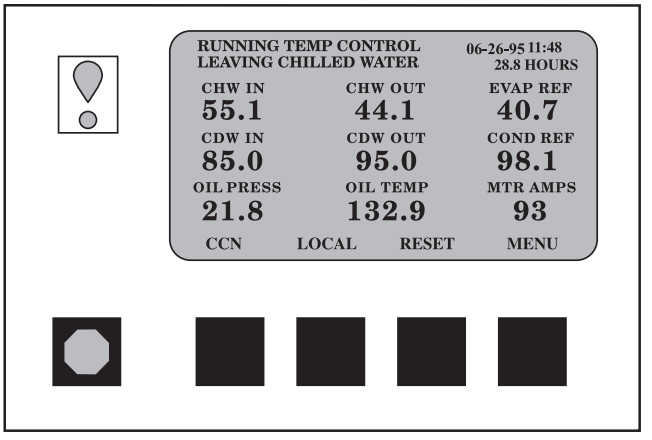
CONTROL CENTER WITH OPTIONS (FRONT VIEW)



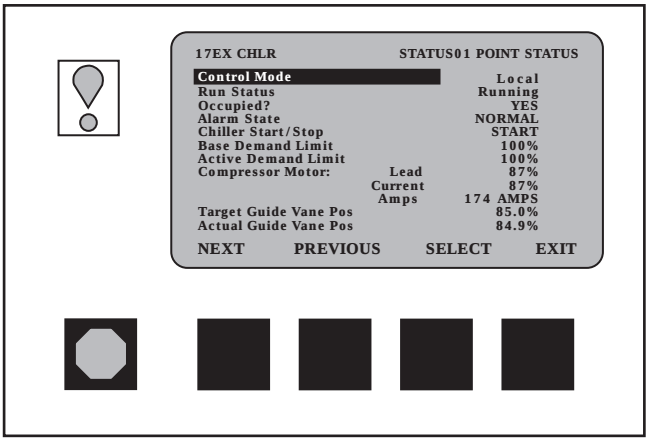
LEGEND

1 — Processor Module (PSIO). The PSIO is the Brain of the Product Integrated Controls
2 — Optional 8-Input Module for Spare Inputs to Control Interface (one of two available)
3 — Local Interface Device (LID Input/ Output Interface Panel Display)
4 — Power Transformer
5 — 6-Pack Relay Board
6 — Circuit Breakers (4)

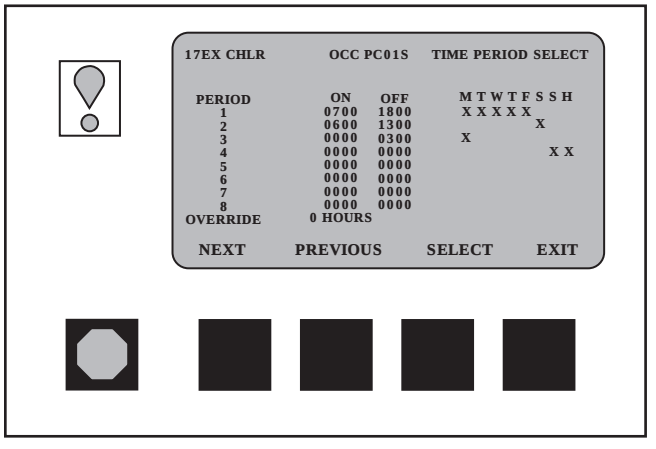
LOCAL INTERFACE DEVICE (LID) TYPICAL DISPLAY PANELS



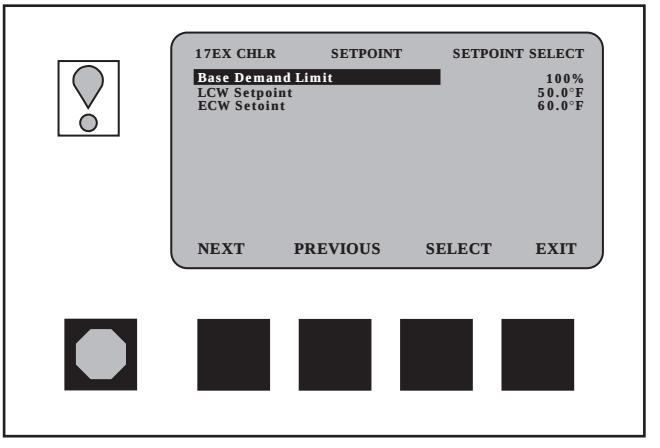
Default Display — Displays information most commonly required for chiller operating logs. Two- line system status messages inform the operator of mode of operation or any alert or alarm messages. The four "softkeys" allow access to other control functions.



Status Screens — The screens display readings of every point monitored by the microprocessor. Cooler, condenser, and oil pressure are included in the status screens.

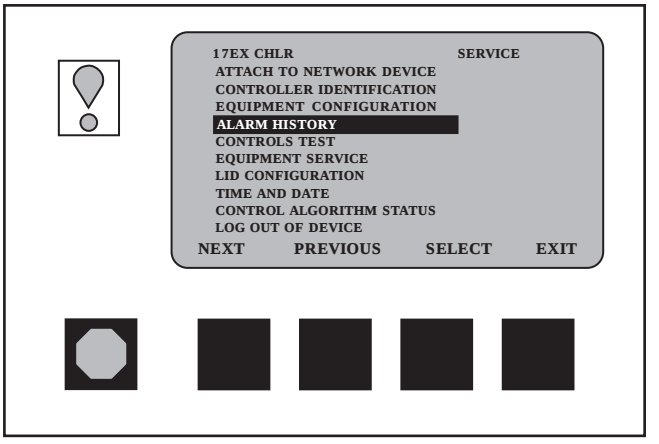


Schedule Screen — A user-established occupancy schedule can easily be configured for your particular application. A 365-day, real time, battery backed-up clock automatically starts and stops the chiller according to your established schedule, or according to the building master schedule in a CCN system.

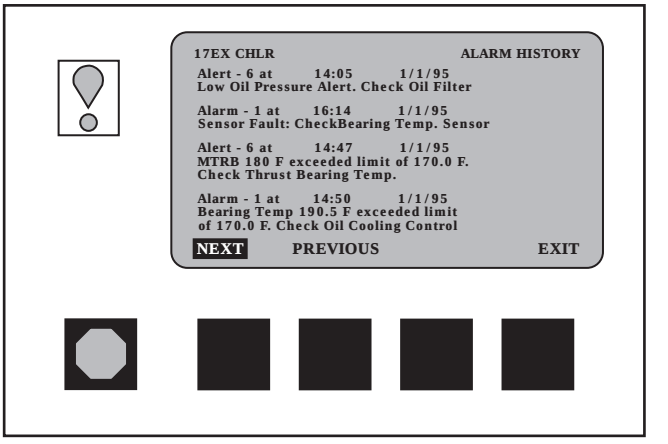


Set Point Screen — The chilled water and demand limit set points can be entered, stored, viewed, or changed easily from this screen.

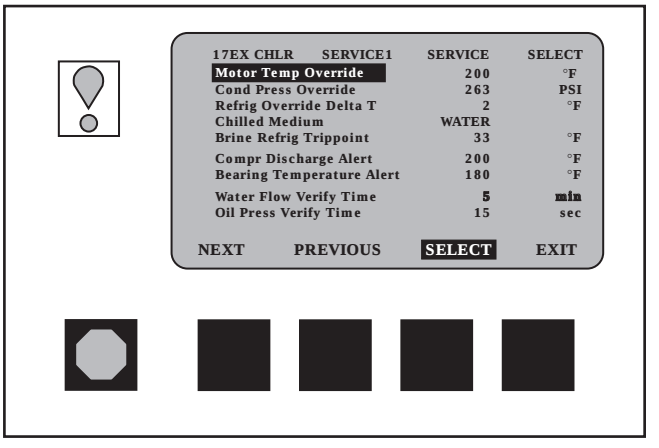
LOCAL INTERFACE DEVICE (LID) TYPICAL DISPLAY PANELS (cont)



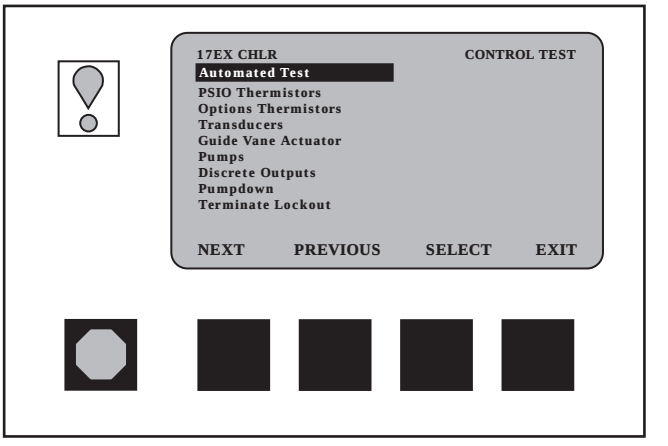
Service Screens — The password-protected service screens provide an array of information available to configure the chiller for your particular application and troubleshoot any problems that may occur.


17EX CHLR ALARM HISTORY
Alert - 6 at 14:05 1/1/95
Low Oil Pressure Alert. Check Oil Filter
Alarm - 1 at 16:14 1/1/95
Sensor Fault: CheckBearing Temp. Sensor
Alert - 6 at 14:47 1/1/95
MTRB 180 F exceeded limit of 170.0 F.
Check Thrust Bearing Temp.
Alarm - 1 at 14:50 1/1/95
Bearing Temp 190.5 F exceeded limit
of 170.0 F. Check Oil Cooling Control
NEXT PREVIOUS EXIT

Alarm History File — Stores the last 25 alarms or alerts that have occurred along with time and date indication. Allows service technician to quickly review alarm or alert history to identify problems that exist, as well as action required to resolve the problem.

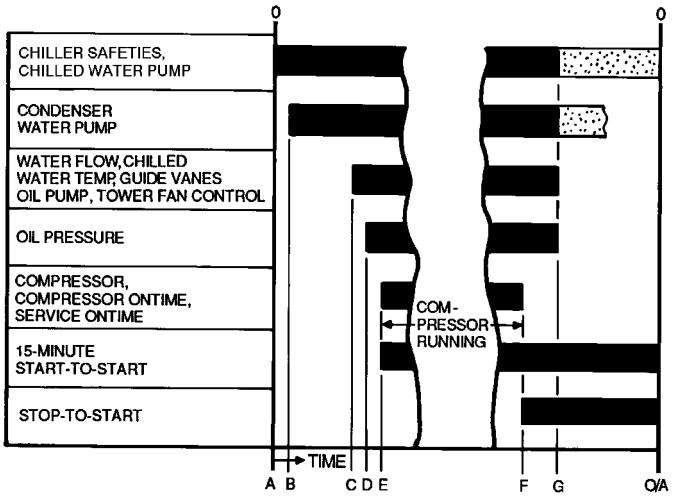

17EX CHLR SERVICE1 SERVICE SELECT
Motor Temp Override 200 °F
Cond Press Override 263 PSI
Refrig Override Delta T 2 °F
Chilled Medium WATER
Brine Refrig Trippoint 33 °F
Compr Discharge Alert 200 °F
Bearing Temperature Alert 180 °F
Water Flow Verify Time 5 min
Oil Press Verify Time 15 sec
NEXT PREVIOUS SELECT EXIT

Service Configuration Screens — Allow configuration of the controls for your particular application and setting override and alert levels for several points monitored by the control system.



Control Test Screen — Allows access to the various controls tests available to the service technician to quickly identify sources of problems and to get the chiller back on line rapidly.

CONTROL SEQUENCE



LEGEND

A — START INITIATED — Prestart checks made; chilled water pump started.
B — Condenser water pump started (5 seconds after A).
C — Water flows verified (one minute to 5 minutes maximum after A). Chilled water temperature checked against control point. Guide vanes checked for closure. Oil pumps started; tower fan control enabled.
D — Oil pressure verified (for compressor, 15 seconds minimum, 300 seconds maximum, after C; for gear, within 30 seconds after C).
E — Compressor motor starts, compressor ontime and service ontime starts, 15-minute inhibit timer starts (10 seconds after D). Start-in-12 hours counter advances by one.
F — SHUTDOWN INITIATED — Compressor motor stops, guide vanes close, compressor ontime and service ontime stops, stop-to-start inhibit timer starts.
G — After the post-lube period, oil and evaporator pumps deenergized. Post-lube configurable to between one and 5 minutes after Step F.
O/A — Restart permitted (both inhibit timers expired) (minimum of 15 minutes after E; minimum of 1 minute after F).

Control sequence

To start: Local start-up (manual start-up) is initiated by pressing the LOCAL menu softkey which is indicated on the default local interface device (LID) screen. Time schedule 01 must be in the occupied mode and the internal 15-minute start-to-start and the 1-minute stop-to-start inhibit timers must have expired. All pre-start alerts are checked to verify that they are within limits. If not, start-up is delayed and the reason is displayed until conditions are within limits. All safeties are checked to verify that they are confirmed within limits (if one is not within the specific limits, an indication of the fault is displayed and the start aborted). The signal is sent to start the chilled water pump. Five seconds later, the condenser water pump is energized. One minute later the controls check to see if flow has been confirmed by the closure of the chilled water and condenser water flow switches. If not confirmed, the PIC continues to monitor flows for a maximum of 5 minutes. When confirmed, it checks the chilled water temperature against the control point. If the temperature is less than or equal to the control point, the condenser water turns off and the controls go into a Recycle mode.

If the water/brine temperature is high enough, the start-up sequence continues and checks the guide vane position. If the guide vanes are more than 6% open, start-up does not occur until the vanes are closed. If the vanes are closed and the oil pump pressure is less than 3 psi (21 kPa), the oil pump is energized, and the tower fan control is enabled. The controls wait a minimum of 15 seconds (maximum, 5 minutes) to verify that the compressor oil pressure has reached 15 psi (103 kPa). At the same time, the controls wait up to 30 seconds to verify that the gear oil pressure has reached 24 psi (166 kPa). After the oil pressures are verified, the controls wait 10 seconds. The compressor start relay is then energized to start the compressor. Compressor ontime and service ontime ''timers'' start, the starts-in-12 hours counter advances by one, and the 15-minute start-to-start timer starts.

Once started: The controls enter the Ramp Loading mode to slowly open the guide vanes to prevent a rapid increase in compressor power consumption. Once completed, the controls enter the Capacity Control mode. Any failure after the compressor is energized that results in a safety shutdown energizes the alarm light and displays the applicable shutdown status on the local interface device (LID) display screen.

Shutdown sequence: Shutdown of the chiller can occur if any of the following events happen:

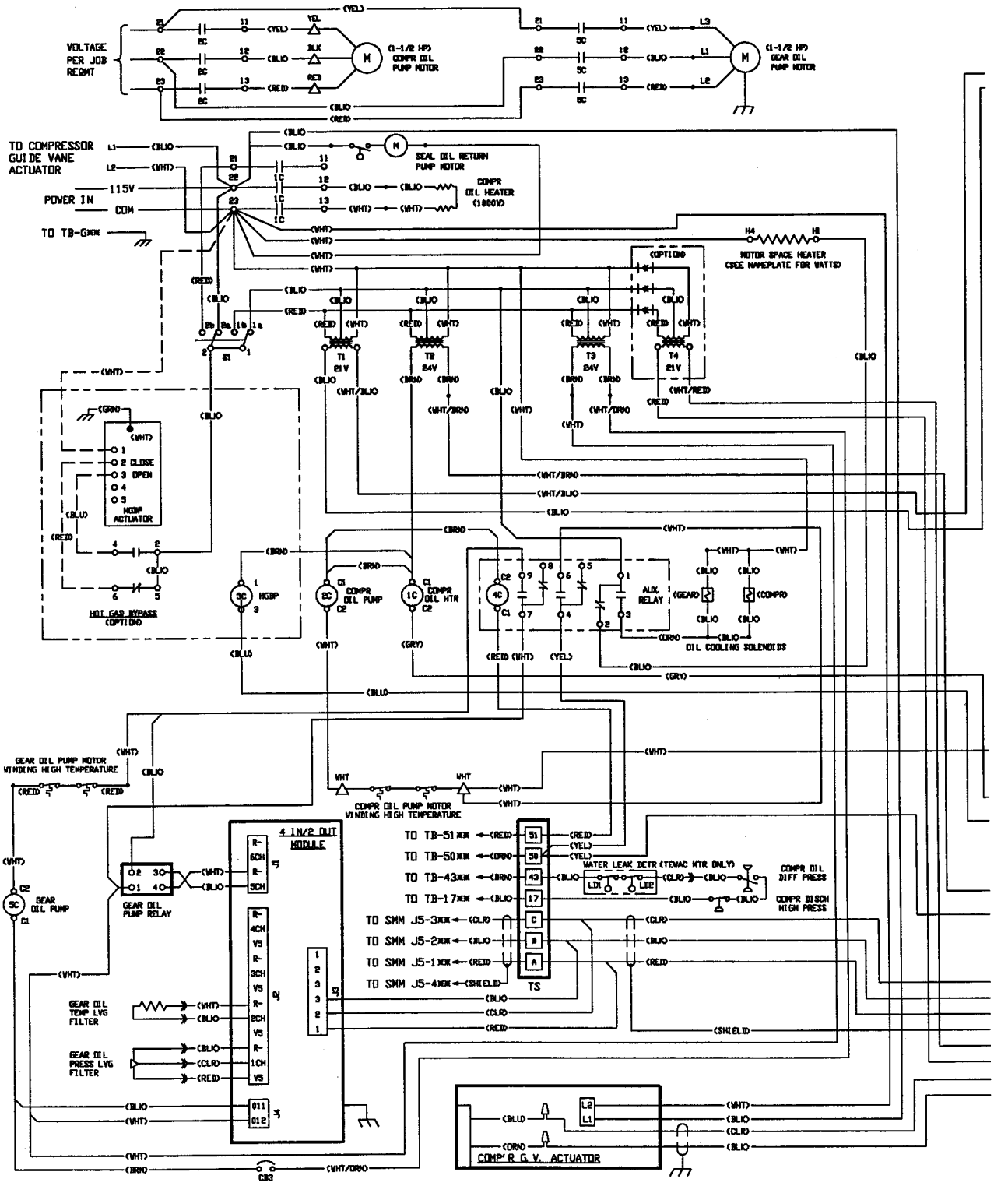
- The stop button is pressed for at least one second
- A recycle shutdown is initiated
- Time schedule has gone into Unoccupied mode
- Chiller or starter protective limit has been reached and chiller is in alarm
- The start/stop status is overridden to stop from the CCN network or LID

Once the chiller is in Shutdown mode, the shutdown sequence first stops the compressor by deactivating the start relay. The guide vanes are then brought to the closed position. Compressor ontime and service ontime stop. The stop-to-start timer starts to count down. The oil pump relay and chilled water pump shut down 60 seconds after the compressor stops. The condenser water pump shuts down when the refrigerant temperature or entering condenser water are below preestablished limits.

If the compressor motor load is greater than 10% after shutdown or the starter contacts remain energized, the oil pump and chilled water pump remain energized and the alarm is displayed.

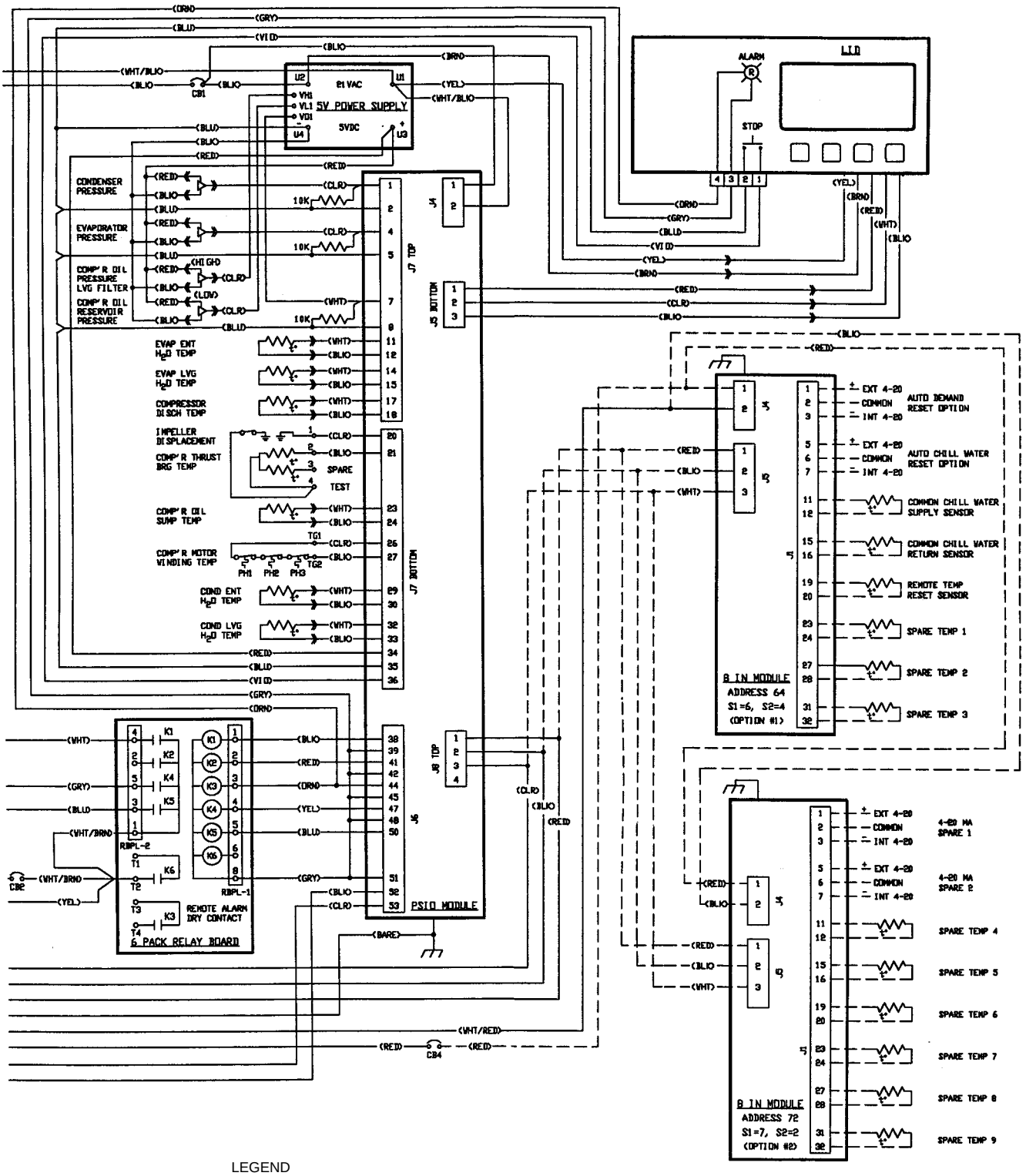
Restart: Restart is permitted after both inhibit timers have expired. If shutdown was due to a safety shutdown, the reset button must be depressed before to restarting the chiller.

Typical control wiring



LEGEND

BRG	— Bearing	**DIFF**	— Differential	**INT**	— Internal
C	— Contactor	**DISCH**	— Discharge	**J**	— Junction
CB	— Circuit Breaker	**ENT**	— Entering	**K**	— Relay Designation
CH	— Channel	**EVAP**	— Evaporator	**L**	— Line Terminal
COM	— Communications	**EXT**	— External	**LD**	— Leak Detector
COMP'R	— Compressor	**G.V.**	— Guide Vane	**LID**	— Local Interface Device
COND	— Condenser	**HGBP**	— Hot Gas Bypass	**LVG**	— Leaving
DETR	— Detector	**HTR**	— Heater	**M**	— Motor

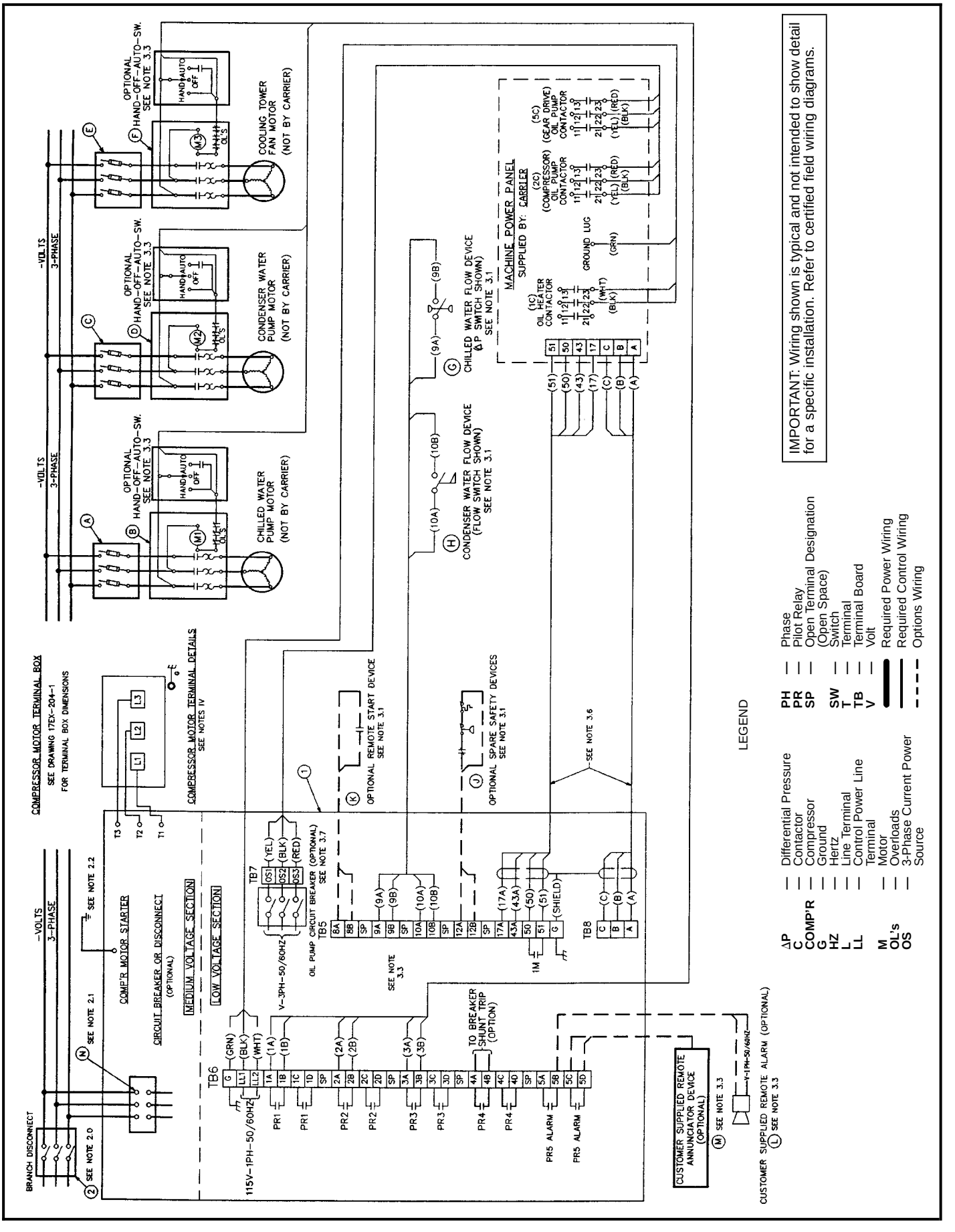


LEGEND

PH	— Phase	**TEMP**	— Temperature
PRESS.	— Pressure	**TEWAC**	— Totally Enclosed Water-to-Air Cooled
PSIO	— Processor/Sensor Input/Output Module	**TG**	— Terminal Designation
R	— Terminal Designation	**TS**	— Terminal Strip
SMM	— Starter Management Module		Required Power Wiring
T	— Terminal		Required Control Wiring
t*	— Thermistor		Options Wiring
TB	— Terminal Block		

IMPORTANT: Wiring shown is typical and not intended to show detail for a specific installation. Refer to certified field wiring diagrams.

Typical field wiring (medium-voltage machine shown)



NOTES FOR TYPICAL FIELD WIRING

NOTES:

I GENERAL

1.0 Starters shall be designed and manufactured in accordance with Carrier Engineering requirement Z-375.

1.1 All field-supplied conductors and devices, field-installation wiring, and termination of conductors and devices must be in compliance with all applicable codes and job specifications.

1.2 The routing of field-installed conduit and conductors and the location of field-installed devices must not interfere with equipment access of the reading, adjusting, or servicing of any component.

1.3 Equipment installation and all starting and control devices must comply with details in equipment submittal drawings and literature.

1.4 Contacts and switches are shown in the position they would assume with the circuit deenergized and the chiller shut down.

1.5 WARNING: Do not use aluminum conductors.

1.6 Installer is responsible for any damage caused by improper wiring between starter and chiller.

II POWER WIRING TO STARTER

2.0 Provide a means of disconnecting power to the starter.

2.1 Power conductor rating must meet minimum unit nameplate voltage and compressor motor RLA (rated load amps). When 3 conductors are used:
Minimum ampacity per conductor =1.25 x compressor RLA.
When 6 conductors are used:
Minimum ampacity per conductor =0.721 x compressor RLA.

2.2 Lug adapters may be required if installation conditions dictate that conductors be sized beyond the minimum ampacity required. Contact starter supplier for lug information.

2.3 Compressor motor and controls must be grounded by using equipment grounding lugs provided inside starter enclosure.

III CONTROL WIRING

3.0 Field supplied control conductors to be at least 18 AWG (American Wire Gage) or larger.

3.1 Chilled water and condenser water flow switch contacts, optional remote start device contacts, and optional spare safety device contacts must have 24 vdc rating. Maximum current is 60 mA; nominal current is 10 mA. Switches with gold plated bifurcated contacts are recommended.

3.2 Remove jumper wire between 12A and 12B before connecting auxiliary safeties between these terminals.

3.3 Pilot relays can control cooler and condenser pump and tower fan motor contactor coil loads rated up to 10 amps at 115 vac or up to 3 amps at 600 vac. Control wiring required for Carrier to start pumps and tower fan motors must be provided to assure chiller protection. If primary pump and tower motor control is by other means, also provide a parallel means for control by Carrier. Do not use starter control transformer as the power source for pilot relay loads.

3.4 Do not route control wiring carrying 30 v or less within a conduit which has wires carrying 50 v or higher or alongside wires carrying 50 v or higher.

3.5 Voltage selector switch in chiller power panel is factory set for 115 v control and oil heater power source. The 230 v position is not used. If switch is set to 230 v position, oil heater will not operate.

3.6 Control wiring cables between starter and power panel must be shielded with minimum rating of 600 v, 80 C. Ground shield at starter. Starter Management Module (SMM) communication cable must be separate.

3.7 If optional oil pump circuit breaker is not supplied within the starter enclosure as shown, it must be located within sight of the chiller with wiring routed to suit.

3.8 Voltage to terminals LL1 and LL2 comes from a control transformer in a starter built to Carrier specifications. Do not connect an outside source of control power to the compressor motor starter (terminals LL1 and LL2). An outside power source will produce dangerous voltage at the line side of the starter, because supplying voltage at the transformer secondary terminals produces input level voltage at the transformer primary terminals.

IV POWER WIRING BETWEEN STARTER AND COMPRESSOR MOTOR

4.0 Medium voltage (over 600 volts) compressor motors have 3 terminals. Connections out of all terminals are no. 1 AWG for all motor sizes. Distance between terminal is 7 9/16 inches. Use suitable splice connectors and insulation for high-voltage alternating current cable terminations (these items are not supplied by Carrier). Compressor motor starter must have nameplate stamped to conform with Carrier requirement Z-375.

4.1 When more than one conduit is used to run conductors from starter to compressor motor terminal box, an equal number of leads from each phase must be in each conduit to prevent excessive heating (e.g., conductors to motor terminals 1, 2, and 3 in one conduit, and those to 1, 2, and 3 in another).

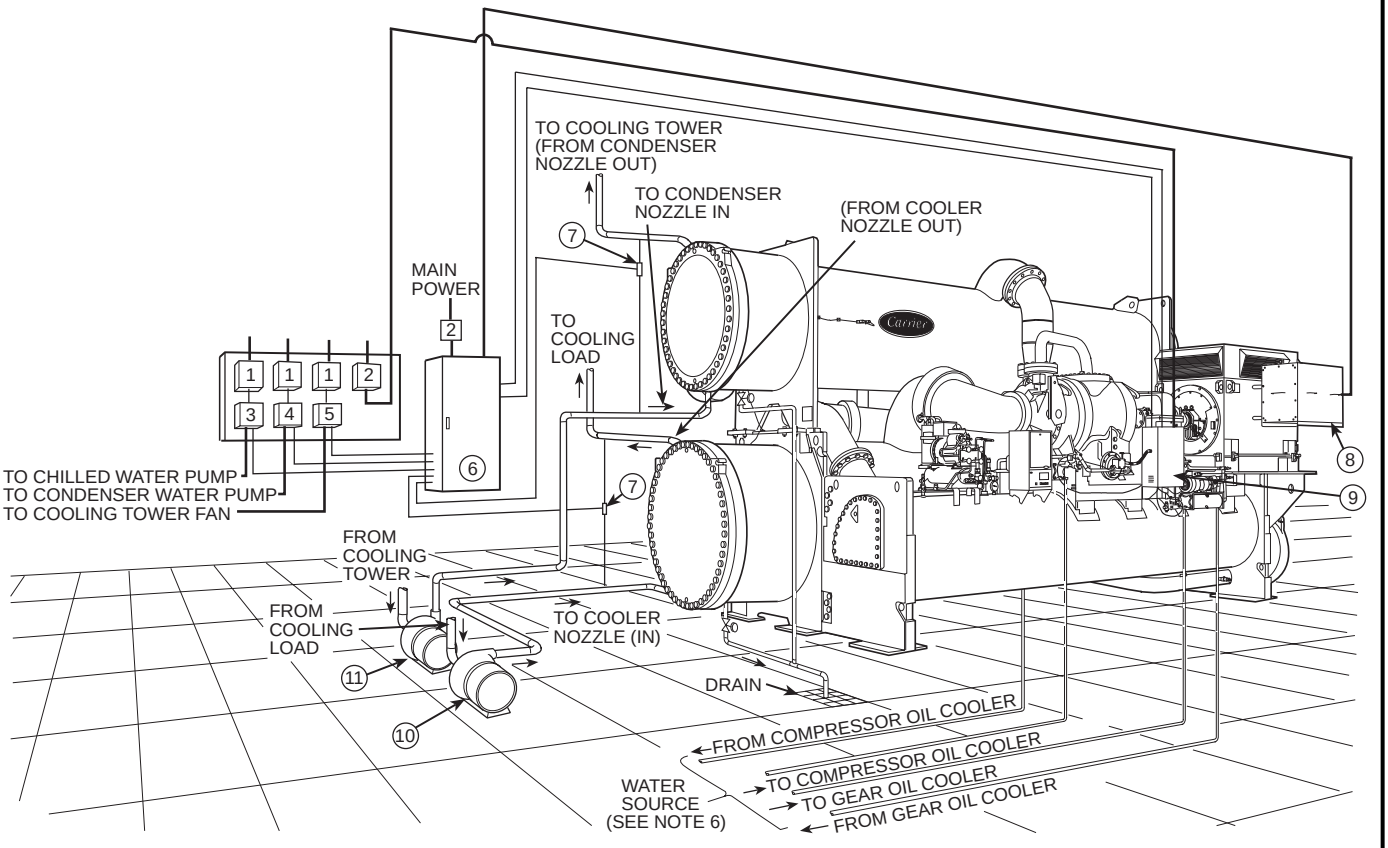
4.2 Compressor motor power connections can be made through top, top rear, or sides of compressor motor terminal box by using holes cut by contractor to suit conduit. Flexible conduit should be used for the last few feet to the terminal box for unit vibration isolation. Use of stress cones may require an oversize (special) motor terminal box (not supplied by Carrier).

4.3 Compressor motor frame to be grounded in accordance with the National Electrical Code (NFPA [National Fire Protection Association] -70) and applicable codes. Means for grounding compressor motor are 2 ground pads, one located near each motor foot opposite the shaft end.

4.4 Do not allow motor terminals to support weight of wire cables. Use cable supports and strain reliefs as required.

Typical piping and wiring

17EX CHILLER WITH FREE-STANDING STARTER



LEGEND

1 — Disconnect
2 — Oil Pump Disconnect (See Note 5)
3 — Chilled Water Pump Starter
4 — Condenser Water Pump Starter
5 — Cooling Tower Fan Starter
6 — Free-Standing Compressor Motor Starter
7 — Differential Pressure Switch
8 — Compressor Motor Terminal Box
9 — Chiller Auxiliary Power Panel
10 — Chilled Water Pump
11 — Condenser Water Pump

Piping
Control Wiring
Power Wiring

NOTES:
1. Wiring and piping shown are for general point-of-connection only and are not intended to show details for a specific installation. Certified field wiring and dimensional diagrams are available on request.
2. All wiring must comply with applicable codes.
3. Refer to Carrier System Design Manual for details regarding piping techniques.
4. Wiring not shown for optional devices such as:
   - Remote Start/Stop
   - Remote Alarms
   - Optional Safety Device
   - 4 to 20 mA Resets
   - Optional Remote Sensors
5. Oil pump disconnect may be located within the enclosure of Item 6 — Freestanding Compressor Motor Starter.
6. Both the gear oil cooler and the compressor oil cooler must be connected to a water source that can deliver sufficient water-side pressure drop through the oil coolers to facilitate the required oil cooler water flow. For example, the water source must meet the following minimum requirements:

SUPPLY TEMPERATURE OF OIL-COOLING WATER	AVAILABLE PRESSURE DROP*
85 F (29.4 C)	28.6 psi (197.1 kPa)
70 F (21.1 C)	19.9 psi (137.2 kPa)
55 F (12.8 C)	12.1 psi (83.4 kPa)
40 F (4.4 C)	5.8 psi (39.9 kPa)

*As measured from the oil cooler inlet to the oil cooler outlet.

Guide specifications

Open Drive Centrifugal Chiller

Size Range: **1500 to 2250 Tons (5820 to 7910 kW) Nominal**

Carrier Model Number: **17EX (with External Gear)**

Part 1 — General

1.01 SYSTEM DESCRIPTION

A. Microprocessor controlled liquid chiller using two-stage hermetic or open centrifugal compressor with HFC-134a refrigerant. Chillers using CFC refrigerants such as CFC-11, CFC-12, or CFC-500 shall not be acceptable. Refrigerants such as HCFC-123 or HCFC-22 are not recommended.

B. If a manufacturer proposes a liquid chiller using HCFC-123 refrigerant, then the manufacturer shall include in the chiller price:

1. A vapor activated alarm system consisting of all alarms, sensors, safeties, and ventilation equipment as required by ANSI/ASHRAE Standard 15 (latest edition) with the quotation. System shall be capable of responding to HCFC-123 levels of 30 ppm Allowable Exposure Limit (AEL).
2. External refrigerant storage tank, pumpout unit, and interconnecting piping.
3. High efficiency purge unit.
4. Relief valve installed in series with rupture disk.
5. A device to prevent an off-line chiller from staying in vacuum at idle and also to act as a manual leak pressurization/detection device during service, equal to PREVAC® as manufactured by Mechanical Ingenuity, Inc. The device shall be factory installed.
6. Labor and materials, including refrigerant, required to convert to HFC refrigerant while guaranteeing design tons and power consumption after conversion. Conversion will be performed any time within 20 years of start-up and after the new HFC refrigerant has been approved by NIOSH or similar authorities.

1.02 QUALITY ASSURANCE

A. Chiller performance shall be rated in accordance with ARI Standard 550 (latest edition), 60 Hz only.

B. Equipment and installation shall be in compliance with Safety Code for Mechanical Refrigeration, ANSI/ASHRAE 15 (latest edition).

C. Cooler and condenser, refrigerant and water side, shall include ASME ''U'' stamp and nameplate certifying compliance with ASME Section VIII, Division 1 code for unfired pressure vessels.

D. Starter enclosure shall conform to NEMA 1.

E. Compressor impellers shall be over-speed tested by manufacturer to a minimum of 10% above continuous operating speed.

F. Motor construction and testing shall comply with NEMA MG1, NEC, and IEEE 112 latest edition standards.

G. Controls shall meet all limitations on radiated and conducted radio-frequency emissions for Class A devices, defined in FCC Rules and Regulations, Part 15, Subpart J.

H. Chiller, controls, and all available options shall meet ISO 9001 requirements.

1.03 DELIVERY, STORAGE, AND HANDLING

A. Unit shall be stored and handled in accordance with manufacturer's instructions.

B. Unit shall be shipped with all refrigerant piping and control wiring factory-installed.

C. Unit shall be shipped with firmly attached nameplate that indicates name of manufacturer, chiller model number, compressor type, and refrigerant used.

1.04 WARRANTY

Warranty shall include parts and labor for one year after start-up or 18 months after shipment, whichever occurs first.

Part 2 — Products

2.01 EQUIPMENT

A. General:

Factory assembled, single-piece, liquid chillers shall consist of an open drive externally geared compressor, motor, lubrication system, cooler, condenser, interstage flash economizer/refrigerant storage vessel, vibration isolation assembly, electrical microprocessor control system, and documentation required prior to start-up. The initial compressor oil charge shall be factory-installed in the chiller. The initial refrigerant charge shall either be factory-installed in the chiller or supplied by the chiller manufacturer for field installation. Motor starter shall be supplied by the chiller manufacturer for field installation.

If heat exchangers and compressor-drive are not supplied as a single piece from the factory, the unit shall include:

1. Rigid, drive line, steel base with compressor and drive factory-mounted and cold-aligned. Drive line water piping shall be terminated at a manifold at the edge of the base. All drive line wiring shall be terminated at a single terminal strip which is clearly labeled.
2. All refrigerant piping shall be cleaned, pickled, sealed, and nitrogen charged to prevent rust and scale build-up during storage. Installation of all refrigerant piping (including interconnecting pumpout piping) shall be the mechanical contractor's responsibility.
3. Hydrostatic testing of the complete unit, including piping, at 1.5 times design pressure. Evacuation, drying, and charging of system after testing shall be provided by manufacturer's start-up personnel.
4. In addition to water, vent, and utilities connections, all interconnnecting tubing, wiring, and piping required to provide a complete ready-to-run unit shall be the responsibility of the mechanical contractor.

B. Compressor:

1. Compressor shall be high-performance centrifugal, two-stage, and externally geared.
2. Compressors shall be open-drive type, arranged for easy servicing. Connections to the compressor shall be flanged for easy disassembly.
3. The internal compressor housing shall be coated with epoxy paint to ensure cleanliness and to prevent oil penetration into the compressor casing.
4. Journal bearings shall be split-housing, pressure-lubricated, self-aligning, pivoting-shoe, steel-backed, babbitt-lined design.
5. Shaft seal shall be floating carbon ring oil film type.
6. Compressor to be supplied with variable inlet guide vanes for capacity control.
7. Compressor to be supplied with an equalizing piston to reduce the load imposed on the thrust bearing.
8. Thrust bearing shall be tilting pad, thrust-equalizing, babbitt-lined, Kingsbury-type.
9. Compressor shall be provided with a factory-installed lubrication system to deliver oil under pressure to bearings. Included in the system shall be:
   a. Hermetic, motor-driven oil pump.
   b. Water-cooled oil cooler.
   c. Oil pressure regulator.
   d. Twenty-micron oil filter with isolation valves.
   e. Oil pump contactor factory-mounted on the chiller and factory-wired to pump motor and control circuit.
   f. Oil sump heater (115 v, 50 or 60 Hz) controlled from unit microprocessor.
   g. Oil reservoir temperature sensor with main control panel digital readout.
   h. Oil pump and motor for a separate 200-240, 380-480, or 507-619 volt, 3 phase, 60 Hz power source, (or 220-240 or 346-440 volt, 3 phase, 50 Hz power source).
   i. If oil pump starter is not factory mounted, all required extra field mounting and wiring shall be done at no additional cost to the owner.
10. Main compressor bearing housing shall be provided with a large, bolted access cover to provide access to main bearings without any other disassembly required.

C. Speed Increaser (External Gear):

1. Transmission shall be single reduction, double helical, parallel shaft speed increaser with lubrication system.
2. The unit shall transmit maximum horsepower (at 1.05 or 1.15 motor service factor) with a minimum AGMA service factor of 1.2 and be provided with hunting-tooth combination gears with split sleeve babbitt-lined bearings.
3. This lubrication package shall be separate from the main compressor lubrication system, and the gear lubrication package shall include the following items:
   a. Air-cooled, motor-driven oil pump.
   b. Water-cooled oil cooler.
   c. Oil pressure regulator.
   d. Thirty-micron oil filter with isolation valves.
   e. Oil pump contactor factory mounted on the chiller and factory-wired to pump motor and control circuit.
   f. Oil supply temperature thermistor with main control panel digital readout.
   g. Oil pump and motor for a separate 200-240, 380-480 or 507-619 volt, 3-phase, 60 Hz power source (or 220-240 or 346-440 volt, 3 phase, 50 Hz power source).
   h. If oil pump starter is not factory mounted, all required extra field mounting and wiring shall be done as no additional cost to the owner.
4. Chiller controls provide for pre- and post-lubrication cycles.

D. Motor:

1. Scope:

   This specification applies to medium and high voltage, two pole, horizontal squirrel cage, induction motors, from 1250 to 2000 brake horsepower (933 to 1492 kW), used to drive centrifugal compressors through an external speed increaser.
2. Electrical Design Requirements:
   a. Synchronous speed of the motor shall be 3600 rpm (60 r/s) at 60 Hz and 3000 rpm (50 r/s) at 50 Hz.
   b. Design operating voltage for 60 Hz motors shall be 2400, 3300, 4160, and 6900 volts. Design operating voltage for 50 Hz motors shall be 3000, 3300, and 6300 volts.
   c. Minimum starting voltage for all motors shall be 65% of design operating voltage.
   d. Starting torque ratings at 100% and 65% of design operating voltage shall be guaranteed.
   e. The motor service factor shall be 1.05 or 1.15.
   f. Stator insulation shall be NEMA class F.
   g. Stator temperature rise shall be NEMA class B at the rated horsepower (1.0 service factor), and NEMA class F at the specified service factor.
   h. The design ambient temperature shall be 104 F (40 C).
   i. The design altitude shall be 3300 ft (1006 m).
   j. Rotation shall be clockwise as viewed from drive end of machine.

3. Mechanical Design Requirements:
   a. The rotor cage shall be constructed of copper or copper alloy. Aluminum rotor bars are not acceptable. All rotor bars shall be fitted and brazed into the core to minimize movement and vibration.
   b. Bearings:
      1) Motor bearings shall be split-sleeve type and babbitt lined. The bearing caps shall be removable, so that the bearings may be inspected and replaced without disturbing the coupling.
      2) Motor bearings shall be self-lubricated, using a two-piece bronze or brass oil ring.
      3) Each motor bearing shall have a sight glass to provide a visual indication of the oil level.
      4) The shaft end play shall not exceed 0.5 inches (13 mm). The magnetic center of the motor shall be within 0.0625 in. (1.6 mm) of the mechanical center of the motor.
      5) The mechanical center of the motor shall be marked on the motor shaft in a manner that will positively fix the point on the motor.
      6) Vibration levels shall not exceed 0.5 mils (0.025 mm) peak-to-peak (unfiltered), 0.12 in./sec (3 mm/sec) shaft velocity as measured on the bearing housing.
4. Enclosures:

   The motor shall be equipped with an open drip-proof (ODP) enclosure. Enclosure shall conform to applicable NEMA standards.
5. Terminal Boxes:
   a. The main motor terminal box shall permit top lead entry.
   b. The main motor terminal box shall be located on the left side of the motor as viewed from the front (end opposite the shaft).
   c. The motor shall be provided with a separate auxiliary enclosure to terminate 115 volt wiring from space heater.
   d. The motor shall be provided with a separate auxiliary enclosure to terminate low voltage devices, such as RTDs, motor overtemperature safety switches, and leak detector contacts.
   e. Oversized conduit box shall be suitable for stress cones.
   f. The main motor terminal box shall accept 6 motor leads, regardless of main motor supply voltage, to allow individual winding tests.
6. Standard Accessories:

   The following accessories shall be included on all motors.
   a. Three overtemperature safety switches with normally closed contacts shall be labeled and terminated at the low-voltage auxiliary junction box.
   b. 115-volt space heaters, sufficiently sized to prevent condensation inside the motor, shall be factory installed and wired to a terminal strip in the 115-volt auxiliary junction box.
   c. Six 100-ohm platinum resistance temperature detectors (RTDs), 2 per phase, shall be imbedded in the stator windings. RTDs are to be labeled and terminated at a labeled terminal strip in a low-voltage auxiliary box.
7. Motor Documentation:
   a. All documentation shall be supplied in the Operation and Maintenance Manual for the chiller.
   b. Nameplate information to include:
      1) Manufacturer's part number
      2) Manufacturer's serial number
      3) Horsepower
      4) Duty rating
      5) Bearing type
      6) Motor type
      7) Motor frame
      8) Motor power supply (volts/phase/hertz)
      9) Date of manufacture
      10) Motor rotation
      11) Ambient temperature rating
      12) Enclosure type
      13) Power factor at full load
      14) Maximum power factor correction capacitor size (KVAR)
      15) Speed at full load
      16) Current at full load
      17) Motor efficiency at full load
      18) Locked rotor current
      19) Motor weight
      20) Motor service factor
      21) Motor NEMA insulation class
      22) Space heater volts/watts
8. Shipment:
   a. The motor shaft shall be shipped coupled to the gear.
   b. Any sensor or other device protruding from the motor shall be protected from normal shipping hazards.
   c. Terminal box shall be packaged and shipped strapped to the top of the motor enclosure.

E. Couplings:
1. Low speed, self-aligning, flexible-disc type with the hub mounted on the drive shaft using a straight fit, single keyway design.
2. High speed coupling shall be flexible-disc type with the hub mounted on the compressor shaft using a tapered fit, double keyway design. Gear shaft shall be straight fit design.
3. Coupling guards shall be installed on both couplings.
4. If the coupling is of a proprietary design, a spare coupling and coupling shaft shall be supplied.
5. High speed coupling shall be balanced to the requirements of AGMA 9000-C90 for the category of ''Normal System Sensitivity.''

F. Cooler and Condenser:

1. Cooler and condenser shall be in separate shells. Heat exchangers shall be fabricated with high performance copper tubing, steel shell-and-tube sheets, and fabricated steel waterboxes.
2. Tubing shall be copper, high-efficiency type with integral internal and external fins. Tubes shall be nominal ¾-in. OD with wall thickness of 0.025 in. (0.635 mm) measured at the root of the fin. Tubes shall be rolled into tube sheets and shall be individually replaceable. End sheets shall be double grooved for joint structural integrity. Cooler tubes shall be expanded into intermediate support sheets. Intermediate tube support sheet spacing shall not exceed 37 in. (940 mm).
3. Waterboxes shall be nozzle-in-head (NIH) design with connections designed for 150 psig (1034 kPa) maximum working pressure unless otherwise noted. Nozzles shall have grooves to allow use of victaulic couplings.
4. The vessel shall display an ASME nameplate that shows pressure and temperature data and the ''U'' stamp for ASME Section VIII, Division 1.
5. Waterboxes shall have vents, drains, and covers to permit tube cleaning within the space shown on the drawings. Suitable tapping shall be provided in waterboxes and nozzles for control sensors.
6. Tubes shall be removable from either end of the heat exchanger without affecting strength and durability of the tube sheet and without causing leakage in adjacent tubes.
7. The condenser shell shall include a FLASC (Flash Subcooler) which cools the condensed liquid refrigerant to a temperature that is below the condensing temperature, thereby increasing the refrigeration cycle efficiency.
8. The tube sheets of the cooler, condenser, and economizer/storage vessel shall be bolted together to allow for field disassembly and reassembly.
9. Safety relief valves shall be installed on the cooler.
10. Cooler shall be designed to prevent liquid refrigerant from entering the compressor.

G. Interstage Flash Economizer/Storage Vessel:

1. Unit shall include an interstage flash economizer/storage vessel that shall be an integral part of the chiller.
2. The vessel shall be large enough to hold the entire refrigerant charge.
3. To improve part load performance, liquid refrigerant shall be metered from the condenser to the cooler using a float-type metering valve to maintain the proper liquid level of refrigerant in the heat exchangers under both full load and part load operating conditions. By maintaining a liquid seal, bypassed hot gas from the condenser to the cooler is eliminated. The float valve chambers shall have bolted access covers.
4. Isolation valves shall be factory installed on the condenser liquid line, cooler liquid line, and economizer gas line. These valves shall allow isolation of the refrigerant charge in the economizer/storage vessel during chiller service.
5. Safety relief valves shall be installed on the flash economizer/storage vessel.

H. Thermal Insulation:

1. Chillers provided with insulation applied at the chiller manufacturer's factory shall require the waterbox and chilled water piping to be insulated by the contractor.
2. Chillers provided with no insulation shall be insulated at the job site per manufacturer's instructions.
3. Insulation shall be ¾-in. (19 mm) thick with a thermal conductivity not exceeding 0.28 $\frac{\text{Btu} \bullet \text{in.}}{\text{hr} \bullet \text{ft}^2 \bullet {}^\circ\text{F}}$ (0.0404 $\frac{\text{W}}{\text{m}}$ °C), shall conform to UL Standard 94, and have classification 8-94 HBF.

I. Vibration Isolation:

1. Chiller manufacturer shall furnish isolator pads for mounting equipment on a level concrete pad surface.
2. If the equipment room floor is not level, the chiller should be ordered with accessory soleplates, jacking screws, and leveling pads for field installation.

J. Controls:

1. The chiller shall be provided with a factory installed and wired microprocessor control center with individually replaceable, modular component construction. Components included shall be the main processor/sensor input/output module, power supply, starter management module (located in starter cabinet), relay board, and temperature and pressure (thermistor and transducer) sensors. The control center includes a 16-line by 40-character liquid crystal display (LCD), 4 softkeys (function keys), a stop button, and an alarm light. The microprocessor can be configured to display either English or SI units.

2. The default standard display screen shall simultaneously indicate the following information:
   a. Date and time of day
   b. 24-character primary system status message
   c. 24-character secondary status message
   d. Chiller operating hours
   e. Entering chilled water temperature
   f. Leaving chilled water temperature
   g. Evaporator refrigerant temperature
   h. Entering condenser water temperature
   i. Leaving condenser water temperature
   j. Condenser refrigerant temperature
   k. Compressor oil differential pressure
   l. Oil sump temperature
   m. Percent motor rated load amps (RLA)

   The default screen shall be displayed if there is no manual activity at the control console for 15 minutes.
3. The 4 control function softkeys are STATUS, SCHEDULE, SETPOINT, and SERVICE.
   a. Status Functions:
      1) Cooler pressure
      2) Condenser pressure
      3) Compressor discharge temperature
      4) Compressor bearing oil temperature
      5) Gear oil temperature
      6) Gear oil pressure
      7) Motor winding temperature switch
      8) Total number of compressor starts
      9) Control point settings
      10) Discrete output status of various devices
      11) Compressor motor starter status
      12) Starter fault status (motor protection)
      13) Status of safety devices and relays.
   b. Schedule Functions:

      Start-up and shutdown shall be manual or automatic. Automatic operation is activated by the user establishing an occupancy schedule based on a 365-day, real-time clock that shall automatically start and stop the chiller according to a configurable stored time. A minimum of 8 separate occupied or unoccupied periods may be scheduled by the user. The periods can have any day of the week or holiday assigned to the occupied or unoccupied periods. Up to 18 user-defined holidays can be configured up to one year in advance (month, day, and duration in days). Simultaneous display of the occupancy schedules shall be visible on the LCD screen. The chiller can also be started and stopped remotely by contact closure from a customer-supplied relay (once this option has been activated in the configuration mode) or from a building management system software command.
   c. Set Point Function:

      The leaving chilled water set point, entering chilled water set point, and demand limit set point shall be entered, stored, viewed, or changed by depressing the set point function softkey. The operator shall be able to modify these set points by entering the set point function and modifying the set points anytime during chiller operation or shutdown periods.
   d. Service Functions:

      By depressing the service function softkey and entering a 4-digit password, the operator shall be able to:
      1) View the alarm history file which contains up to 25 alarm/alert messages with time and date stamp.
      2) Execute the chiller controls test function for quick identification of malfunctioning components.
      3) View/modify chiller configuration.
      4) View/modify chiller occupancy periods.
      5) View/modify schedule holiday periods.
      6) View/modify schedule override periods.
      7) View/modify system time and date.
4. Capacity control shall be by means of variable inlet guide vanes located at the impeller inlet. Load modulation shall be from 100% to 10% of full load under normal ARI conditions without the use of hot gas bypass. The guide vanes are precisely positioned by the PID (proportional-integral-derivative) control algorithm to ensure precise control (± .5 F or .3 C) of desired chilled water temperature without hunting or overshooting the set point.
5. The microprocessor control system shall include a programmed sequence to meet pre-lube needs prior to chiller start-up and a programmed, variable (from 1 to 5 minutes) sequence to meet post-lube needs during coast-down after the chiller stops. The microprocessor shall automatically activate and interlock the chilled water pump, condenser water pump, and cooling tower fans upon chiller activation.
6. Upon request to start the compressor the control system shall start the chilled water pump and condenser water pump; verify that flow has been established; and then compare leaving chilled water temperature with the chilled water set point. If the chilled water temperature is less than the chilled water set point, the control system will shut down the condenser water pump and wait for the cooling load to be established. If the water/brine temperature is high enough, the start-up sequence continues and checks the guide vane position. If the guide vanes are more than 6% open, start-up shall not occur until the vanes are closed. If the vanes are closed and the oil pump pressure is less than 3 psi (21 kPa), the oil pump

shall be energized, and the tower fan control is enabled. The controls wait a minimum of 15 seconds (maximum, 5 minutes) to verify that the compressor oil pressure has reached 15 psi (103 kPa). At the same time, the controls wait up to 30 seconds to verify that the gear oil pressure has reached 24 psi (166 kPa). After the oil pressures are verified, the controls wait 10 seconds. The compressor start relay is then energized to start the compressor. Compressor ontime and service ontime ''timers'' start, the starts-in-12 hours counter advances by one, and the 15-minute start-to-start timer shall start.

7. A user-configurable ramp loading rate, effective during the chilled water temperature pulldown period, slows the rate of guide vane opening to prevent a rapid increase in compressor power consumption. Ramp loading limits the rate (degrees/minute) of chilled water temperature pulldown or percent demand limit to the user-configurable rate. During the ramp loading period, a message shall be displayed informing the operator that the chiller is operating in ramp loading mode.
8. The control system shall include 2 compressor cycle-timers to protect the motor from rapid cycling. The start-inhibit timer shall prevent rapid compressor restart by limiting the start-to-start time to 15 minutes minimum and stop-to-start time to 1 minute minimum. In addition, the compressor shall be inhibited from restarting if more than 8 manual starts per 12-hour period have occurred.
9. The control system shall automatically cycle the compressor off to minimize energy usage whenever the leaving chilled water temperature is 5 F (3 C) below the desired chilled water set point. The chilled water pump will remain on. When the leaving chilled water temperature rises above the desired set point, the compressor will automatically restart. During the shutdown period, a message shall be displayed informing the operator a recycle restart is pending.
10. The control center shall monitor line voltage. If loss of voltage, high or low line voltage, or single cycle dropout is sensed, the chiller will shut down. Upon restoration of line voltage, if the auto-start after power failure algorithm was activated in the configuration mode, the chiller shall automatically restart and resume the mode of operation prior to shutdown.
11. The control center shall allow reset of chilled water temperature set point based on any one of the following criteria:
    a. Chilled water reset based on an external 4 to 20 mA signal.
    b. Chilled water reset based on a remote temperature sensor (such as outdoor air).
    c. Chilled water reset based on water temperature rise across the evaporator.

    When reset is active, a message shall be displayed indicating the source of reset signal.
12. The control center shall limit amp draw of the compressor to the rated load amps or to a lower value based on the following criteria:
    a. Demand limit based on a user input ranging from 40% to 100% of compressor rated load amps.
    b. Demand limit based on an external 4 to 20 mA signal.

    When demand limit is active, a message shall be displayed indicating the source of the demand signal.

K. Safeties:

1. Unit shall automatically shut down when any of the following conditions occur: (Each of these protective limits shall require manual reset and cause an alarm message to be displayed on the LCD screen informing the operator of the shutdown cause.)
    a. Motor overcurrent
    b. Over voltage
    c. Under voltage
    d. Single cycle dropout
    e. Compressor bearing oil high temperature
    f. Low evaporator refrigerant temperature
    g. High condenser pressure
    h. High motor temperature switch status
    i. High compressor discharge temperature
    j. Low compressor oil pressure
    k. Low gear oil pressure
    l. High gear oil temperature
    m. Prolonged surge
    n. Loss of cooler water flow
    o. Loss of condenser water flow
    p. Starter fault
2. The control system shall detect conditions that approach protective limits and take self-corrective action prior to an alarm occurring. The system shall automatically reduce chiller capacity when any of the following is out of normal operating range:
    a. High condenser pressure
    b. Low cooler refrigerant temperature

    During the capacity override period, a prealarm (alert) message shall be displayed informing the operator of the condition causing the capacity override. Once the condition is again within acceptable limits, the override condition shall be terminated and the chiller shall revert to normal chilled water control. If during either condition the protective limit is reached, the chiller shall shut down and a message shall be displayed informing the operator which condition caused the shutdown and alarm.

L. Diagnostics and Service:

1. The control system shall execute a series of prestart checks whenever a start command is received to determine if pressures, temperatures, and times are within normal limits, thereby allowing a normal start-up to commence. If any of the limits are exceeded, an alert message will be displayed informing the operator of the cause of the prestart alert.
2. A self-diagnostic control test shall be an integral part of the control system to allow quick identification of malfunctioning components. Once the control tests have been initiated, all pressure and temperature sensors shall be checked to ensure they are within normal operating range. A pump test shall automatically energize the chilled water pump, condenser water pump, and oil pumps. The control system shall confirm that water flow and oil pressure have been established and require operator confirmation prior to proceeding to the next test. A guide vane actuator test shall open and close the guide vanes to check for proper operation. The operator manually acknowledges proper guide vane operation prior to proceeding to the next test.

   In addition to the automated control test, a thermistor test and transducer test shall allow display on the LCD screen of the actual reading of each transducer and each thermistor installed on the chiller. All sensors shall have quick disconnects to allow replacement of the sensor without replacement of the entire sensor wire.

M. Building Control System Interface:

The chiller control system shall have the ability to interface and communicate directly to the building control system without the use of additional field installed hardware or software. The building control system and the centrifugal chiller must be supplied by the same manufacturer.

N. Multiple Chiller Control:

The chiller controls shall be supplied as standard with a two chiller lead/lag with third chiller standby system. The control system shall automatically start and stop a lag or second chiller on a two chiller system. If one of the two chillers on line goes into a fault, the third standby chiller shall be automatically started. The two chiller lead/lag system shall allow manual rotation of the lead chiller, include load balancing, if configured, and staggered restart of the chillers after a power failure.

For systems with more than two operational chillers, a Chillervisor System Manager (CSM) module shall be field-installed in the control center of one of the chillers. This control system can automatically control up to 8 chillers in the same plant room. If desired, other components of the chiller water plant, such as cooling towers, pumps, and valves can be controlled by additional software supplied by the chiller manufacturer.

O. Electrical Requirements:

Electrical Contractor shall:

1. Handle and install the compressor motor starter in accordance with the diagrams and instructions of the chiller manufacturer.
2. Supply and install all electric lines, disconnect switches, circuit breakers, electrical protection devices, and motor terminal lugs.
3. Wire the water flow switches in the control circuit to ensure that chiller will not operate until flows are established and maintained.
4. Supply electrical power to the oil pump contactors and oil heater contactor terminals with the characteristics as noted in the equipment schedule. Supply shall be independent of main compressor motor breaker or disconnect.
5. Supply electrical power to the unit at the voltage, phase, and frequency listed in the equipment schedule.

P. Piping Requirements:

Mechanical Contractor shall:

1. Supply and install the water piping to the nozzles of the cooler and condenser and shall make provisions for removal and replacement of piping when required to provide access for cleaning the cooler and condenser tubes.
2. Make water connections to all water supply drain and vent connections as required by equipment drawings and local codes.
3. Supply and install refrigerant vent (relief) lines to outdoors as required on equipment drawings and per ASHRAE 15.
4. Supply and install pressure gages in readily accessible locations in piping adjacent to the chiller so they can be easily read from a standing position on the floor. Gages shall be Marsh Master or equal with 4½-in. (114 mm) nominal diameter dial face. Scale range shall be such that design values shall be indicated at approximately mid-scale. Gages shall be installed in the entering and leaving water lines to the cooler and condenser.
5. Supply and install thermometers in readily accessible locations in piping adjacent to the chiller so they can be easily read from a standing position on the floor. Thermometers shall be Moeller or equal; adjustable, with 7-in. (178 mm) long glass-faced metal cases and separable sockets and wells. Bulbs shall project sufficiently into the pipe to accurately measure fluid temperature. Cases shall have extensions of sufficient length to clear insulation. Thermometers shall be installed in the entering and leaving water lines to the cooler and condenser.
6. Supply and install differential pressure switches in chilled water and condenser water piping. Switches shall make contact when flow is established. Switches shall be installed in horizontal runs at least 5 pipe diameters downstream from any bend or tee.

Q. Start-up:

1. The chiller manufacturer shall provide a factory-trained representative, employed by the chiller manufacturer, to perform the start-up procedures as outlined in the Start-Up, Operation, and Maintenance manual provided by the chiller manufacturer.
2. After the above services have been performed, the same factory-trained representative shall be available for a period of classroom instruction not to exceed an 8-hour day to instruct the owner's personnel in the proper operation and maintenance of the chiller.
3. Contractor shall supply the owner with the following literature as furnished by the manufacturer prior to start-up:
   a. One complete set of installation drawings.
   b. Installation Instructions.
   c. Start-Up, Operation, and Maintenance Instructions.
   d. Field wiring diagrams.

R. Maintenance:

The manufacturer's service division shall perform a visual inspection of the main compressor bearings and check the tolerance of the thrust bearings during the shutdown period of the third year of operation for each chiller. Vibration and oil analysis in lieu of visual inspection is not acceptable.

S. Field-Installed Accessories:

The following standard accessories are available for field installation:

1. Soleplate Package:

   Unit manufacturer shall furnish a soleplate package consisting of soleplates, jacking screws, leveling pads, and neoprene pads.
2. Spring Isolators:

   Field furnished and selected for the desired degree of isolation.
3. Spare Sensors with Leads:

   Unit manufacturer shall furnish additional temperature sensors and leads to be used in conjunction with the controls options module upgrade kit.
4. Control Options Module Upgrade Kit:

   Unit manufacturer shall furnish an 8-input control module required to provide chilled water reset from 4 to 20 mA signal or remote temperature sensor, auto demand limit from 4 to 20 mA signal, or monitoring common supply and return chilled water temperature for multiple chiller control. Accessory includes options transformer for installation in power panel. The 8-input module shall be capable of generating a 20 mA current supply for modulation by others or accepting a 4 to 20 mA input from others.
5. Sound Insulation Kit:

   Unit manufacturer shall furnish a sound insulation kit that covers the compressor housing, compressor discharge pipe, condenser shell, condenser liquid line, and economizer gas pipe.
   a. Inner and outer jacket construction shall be 17 oz/sq yd PTFE Teflon impregnated fiberglass cloth.
   b. Insulation material shall be 11 lb/cu ft fiberglass needled material with Barium Sulfate loaded vinyl acoustic barrier.
   c. Blanket construction shall be double sewn and lock stitched with minimum of 7 stitches per inch using Teflon-coated, fiberglass thread. All raw jacket edges shall have a tri-fold Teflon cloth binding. No raw cut edges shall be exposed.
   d. Insulation design shall accommodate temperature and pressure probes, gages, tubing, piping, and brackets.
   e. To avoid penetrating noise at mating seams, blanket pieces shall include an extended 2-in. wide vinyl flap. This flap shall cover all exposed seams, thereby minimizing any potential noise leaks.
   f. An aluminum nameplate shall be riveted to each blanket piece. Each tag shall be embossed or etched with lettering indicating piece location, description, size, pressure rating, and tag number sequence.
   g. To enhance blanket quality and maintain uniform thickness, stainless steel quilting pins shall be placed at random locations no greater than 18 in. apart to prevent shifting of the insulation filler.
6. Flow Switches:

   Furnished by unit manufacturer or field furnished.

T. Factory-Installed Options:

The following standard options, if selected, are factory installed. Certain options will supersede the standard features listed previously and are indicated by an (*).

* 1. Thermal Insulation:

Unit manufacturer shall insulate the cooler shell, economizer, compressor suction elbow, and all interconnecting piping and tubes. Insulation shall be ¾ in. (19 mm) thick with a thermal conductivity not exceeding 0.28 $\frac{\text{Btu} \bullet \text{in.}}{\text{hr} \bullet \text{ft}^2 \bullet {}^\circ\text{F}}$ (0.0404 $\frac{\text{W}}{\text{m}}$ °C) form to UL Standard 94, classification 94 HBF.

2. Multi-Pass Heat Exchangers:

   One, 2, and 3 pass heat exchangers are available for all heat exchanger sizes with the exception of condenser sizes 55-57, which come as only 1 or 2 pass.

* 3. Automatic Hot Gas Bypass:

   Hot gas bypass valve and piping, designed to artificially load the evaporator, shall be factory furnished to permit chiller operation down to 5% of full load capacity for extended periods of time.

4. Controls Option Module:

   Unit manufacturer shall install an 8-input control module required to provide chilled water reset from 4 to 20 mA signal or remote temperature sensor, auto demand limit from 4 to 20 mA signal, or monitoring common supply and return chilled water temperature for multiple chiller control. Option shall include a transformer in the power panel.

5. Hinged Waterbox Covers:

   Unit manufacturer shall install hinges on the cooler and/or condenser waterbox cover(s) to facilitate tube cleaning. Each cover designated to be hinged shall incorporate 2 hinges with jacking screws to ensure proper cover support and alignment.

* 6. Cooler and Condenser Tubes:

   a. Unit manufacturer shall provide ¾-in. outside diameter copper tubes in the cooler and/or condenser that are internally enhanced and have 0.028-in. wall thickness.

   b. Unit manufacturer shall provide ¾-in. outside diameter copper tubes in the cooler and/or condenser that are internally enhanced and have 0.035-in. wall thickness.

   c. Unit manufacturer shall provide ¾-in. outside diameter copper tubes in the cooler and/or condenser that are smooth bore and have 0.028-in. wall thickness.

   d. Unit manufacturer shall provide ¾-in. outside diameter copper tubes in the cooler and/or condenser that are smooth bore and have 0.035-in. wall thickness.

   e. Unit manufacturer shall provide ¾-in. outside diameter 90/10 CuNi tubes in the cooler and/or condenser that are smooth bore and have 0.028-in. wall thickness.

   f. Unit manufacturer shall provide ¾-in. outside diameter 90/10 CuNi tubes in the cooler and/or condenser that are smooth bore and have 0.035-in. wall thickness.

   g. Unit manufacturer shall provide ¾-in. outside diameter 90/10 CuNi tubes in the cooler and/or condenser that are internally enhanced and have 0.028-in. wall thickness.

   h. Unit manufacturer shall provide ¾-in. outside diameter 90/10 CuNi tubes in the cooler and/or condenser that are internally enhanced and have 0.035-in. wall thickness.

   i. Unit manufacturer shall provide ¾-in. outside diameter titanium tubes in the condenser that are smooth bore and have 0.028-in. wall thickness.

   j. Unit manufacturer shall provide ¾-in. outside diameter titanium tubes in the condenser that are internally enhanced and have 0.025-in. wall thickness.

   k. Unit manufacturer shall provide ¾-in. outside diameter titanium tubes in the condenser that are internally enhanced and have 0.028-in. wall thickness.

* 7. Nozzle-In-Head, 300 psig (2068 kPa):

   Unit manufacturer shall furnish nozzle-in-head style waterboxes on the cooler and/or condenser rated at 300 psig (2068 kPa).

* 8. Marine Waterboxes, 150 psig (1034 kPa):

   Unit manufacturer shall furnish marine style waterboxes on the cooler and/or condenser rated at 150 psig (1034 kPa).

* 9. Marine Waterboxes, 300 psig (2068 kPa):

   Unit manufacturer shall furnish marine style waterboxes on the cooler and/or condenser rated at 300 psig (2068 kPa).

* 10. Flanged Water Nozzles:

   Unit manufacturer shall furnish standard flanged piping connections on the cooler and/or condenser.

11. Factory Performance Test:

   Unit manufacturer shall provide a certified (nonwitnessed) or witnessed single point performance test per the latest version of ARI-550 test procedures. Additional points shall be available as an option.

12. Pumpout System:

   A refrigerant pumpout system shall be installed on the chiller. The pumpout system shall include a 3-hp compressor and drive, piping, wiring, and motor. The storage vessel shall be integral to the chiller, external to the unit cooler or condenser shells, and shall be large enough to hold the entire refrigerant charge. Isolation of the refrigerant in the cooler or condenser during servicing shall be unacceptable.

13. Weatherproof Type II Motor Enclosure (WPII):

   Unit manufacturer shall supply a type II weatherproof enclosed motor.

14. Totally Enclosed Water-to-Air Cooled (TEWAC) Motor Enclosure:
    a. The heat exchanger for the TEWAC enclosure shall be double tube type. Tube material shall be 90/10 cupronickel.
    b. The heat exchanger shall be designed for a maximum entering water temperature of 85 F (29 C), with a fouling factor of 0.001 hr.-sq.-ft-F/Btu, and maximum water pressure of 150 psig (1034 kPa).
    c. A factory-installed moisture detector shall sense any leak into the air layer between the tubes and activate a normally closed switch (opens when leak is detected). The switch shall be rated for 60 mA at 24 vdc, and shall be labeled and wired to the low-voltage auxiliary junction box.
15. Provide one 100-ohm platinum RTD (resistance temperature detector) in each motor bearing. Label and terminate connections at a labeled terminal strip in a low-voltage auxiliary junction box.
16. Ship the chiller charged with refrigerant HFC-134a as specified on the equipment schedule.

Manufacturer reserves the right to discontinue, or change at any time, specifications or designs without notice and without incurring obligations